Bioretention for Infiltration
DNR Conservation Practice Standard 1004

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Post-Construction Stormwater Management Workshop

November - December 2004

WISCONSIN
DEPT. OF NATURAL RESOURCES

Presentation Outline

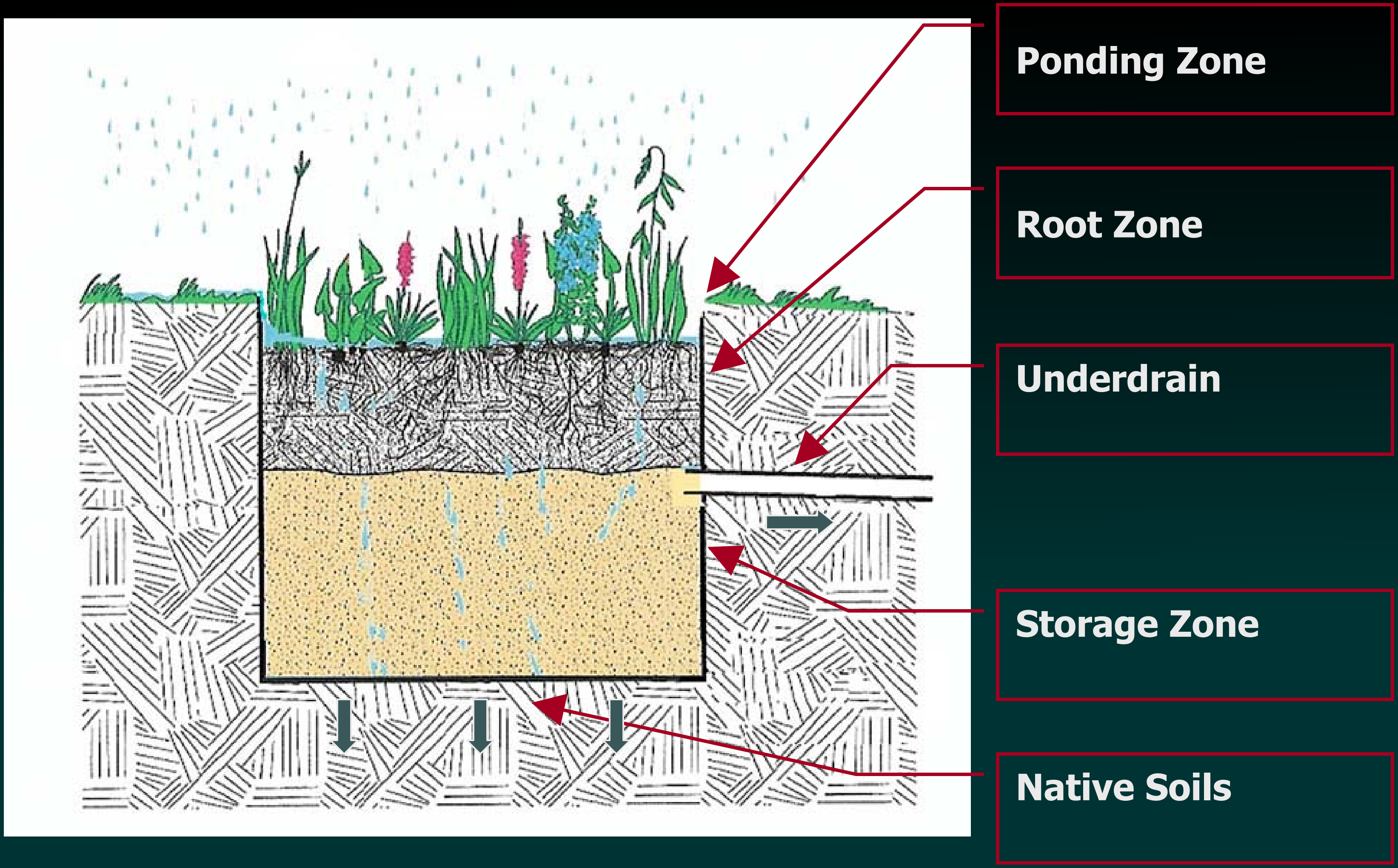
- Background Information
  - What, where and why
- DNR Conservation Practice Standard 1004
  - Requirements, recommendations
- Determining Required Surface Area
  - RECARGA
  - Design example using RECARGA
- Additional Questions & Answers

Bioretention:
What, Why and Where

Part I. Definition

- Engineered infiltration device providing physical, chemical & biological treatment
  - May include pre-treatment area and flow regulation devices
- Excavation back-filled with soil mix
  - Includes "pond zone"
  - May include underdrain, gravel storage layer and native soil interface layer
- Planted with diverse vegetation and mulched

Basic Facility Components



Part II. Purpose

- Primary purpose as designed is to enhance stormwater infiltration to meet NR 151
- Other important impacts
  - Reduces pollutant discharges (NR 151)
  - Reduces peak-flow runoff (NR 151)
  - Preserves base-flows
  - Reduces thermal impacts

Part III. Conditions Where Practice Applies

- Bioretention is applicable to:
  - Variety of settings, including ultra-urban
  - Small drainage areas adjacent to source areas
  - Other amenities desired (shade, windbreak, garden)

- Do not use bioretention:
  - For construction site erosion control
  - In areas of heavy chloride use

Part IV. Federal, State, Local Laws

User of this standard must comply with all applicable laws, rules, regulations and permit requirements governing bioretention devices.

Part V. Criteria
A. Siting

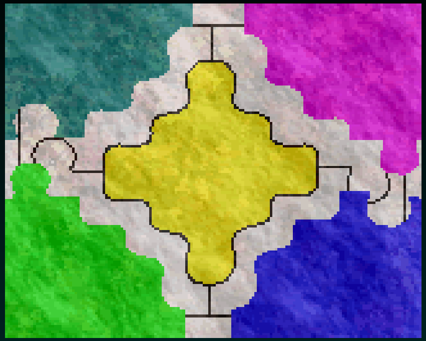
- Shall evaluate site using DNR Standard 1002
- POWTS
  - Shall have no hydraulic connections; stay 50 feet away
- Foundations
  - Shall have no hydraulic connections with pavement/building foundations
- Adjacent Slopes
  - Shall be 0.5% - 20% (pavement areas); 1% - 20% (vegetated areas)
- Maximum Drainage Area
  - Shall not exceed 2 acres
  - Shall not contain significant erosion sources

Part V. Criteria
General Design Requirement

- Shall use an approved model to determine the required facility area
- DNR Technical note includes an approved model for:
  - Target Stay-on Depth
  - Facility Area (RECARGA)
  - See Consideration L. in standard for Web link

Part V. Criteria

B.1. Design: Detailed Configuration



Examples in Figures 1-3

DNR Conservation Practice Standard 1004

Figure 1. Example of **Bioretention Device** – **plan view**

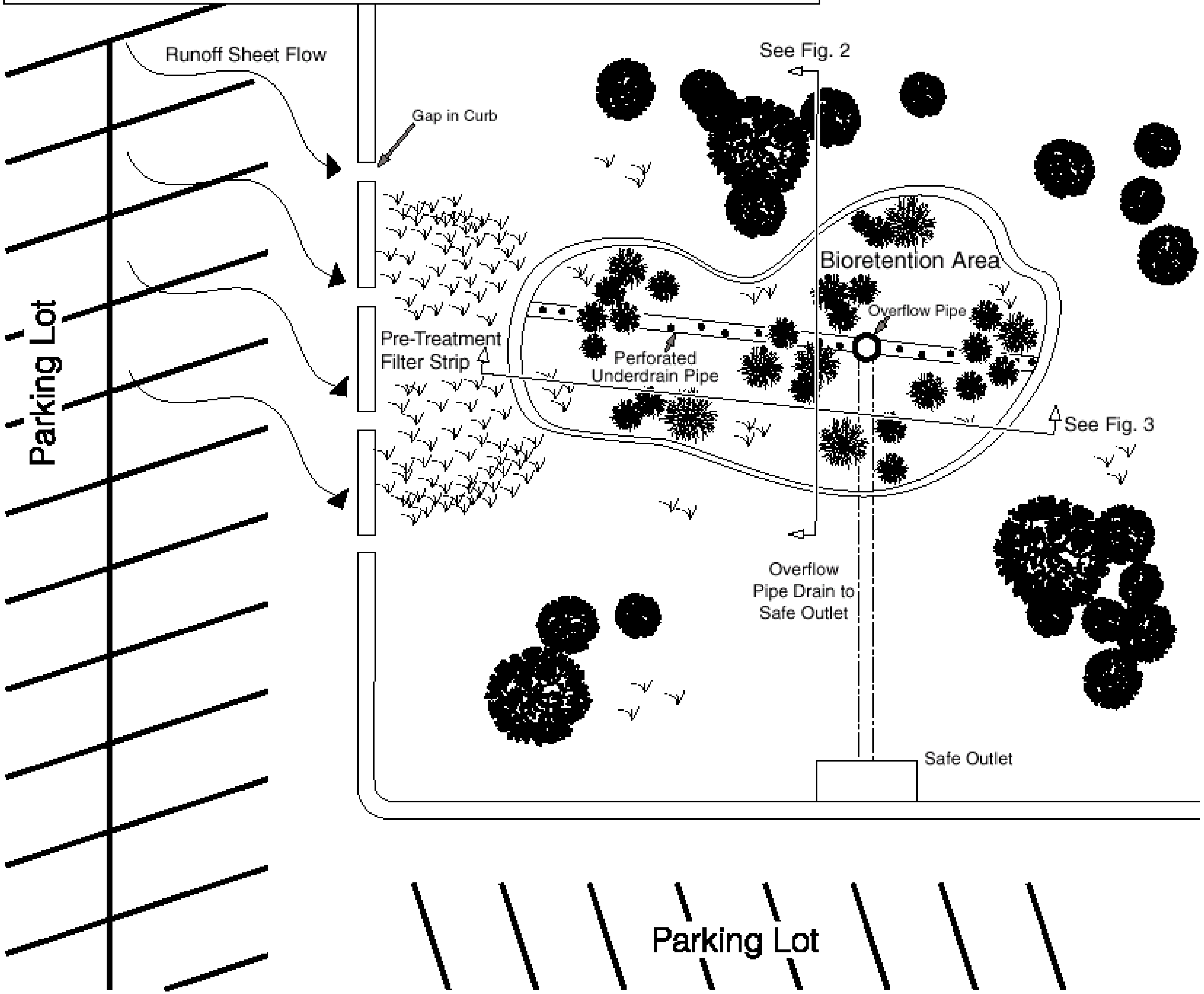


Figure 2. Example of **Bioretention Device** – **cross-section across width of device**

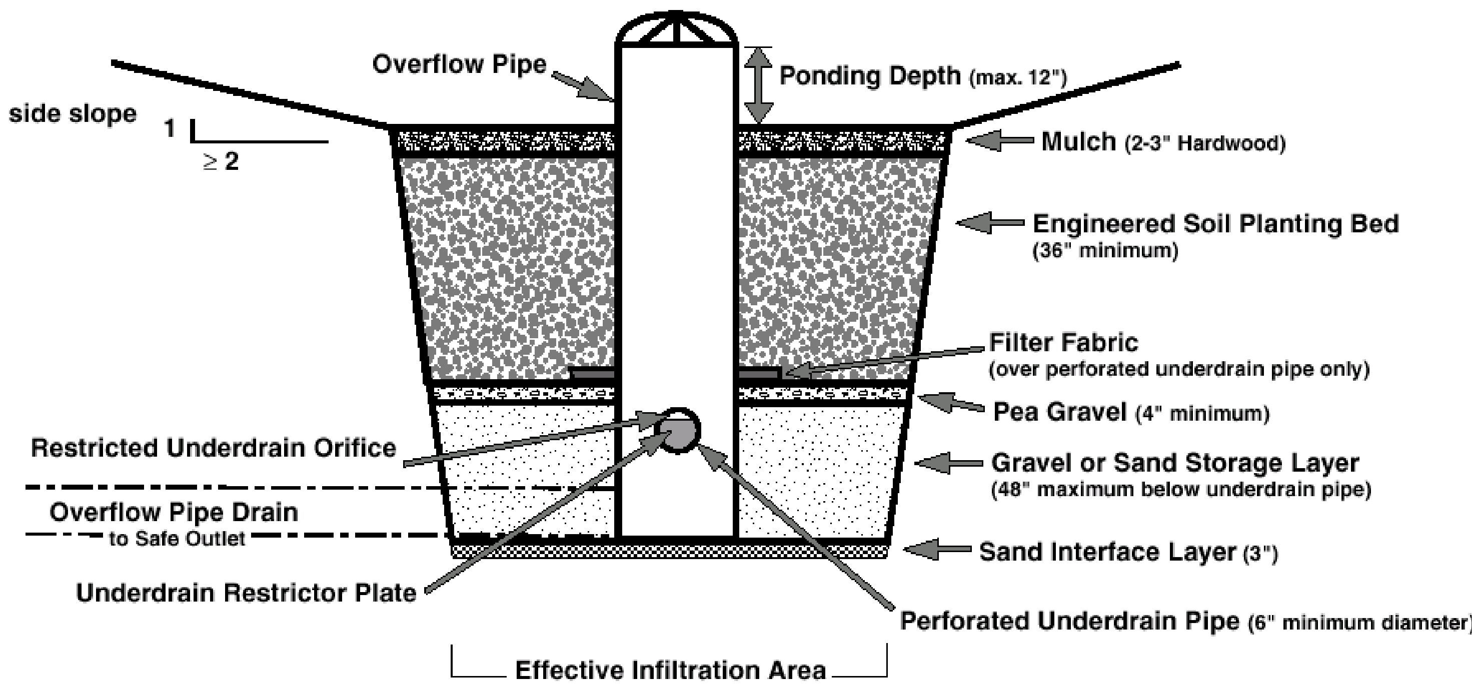
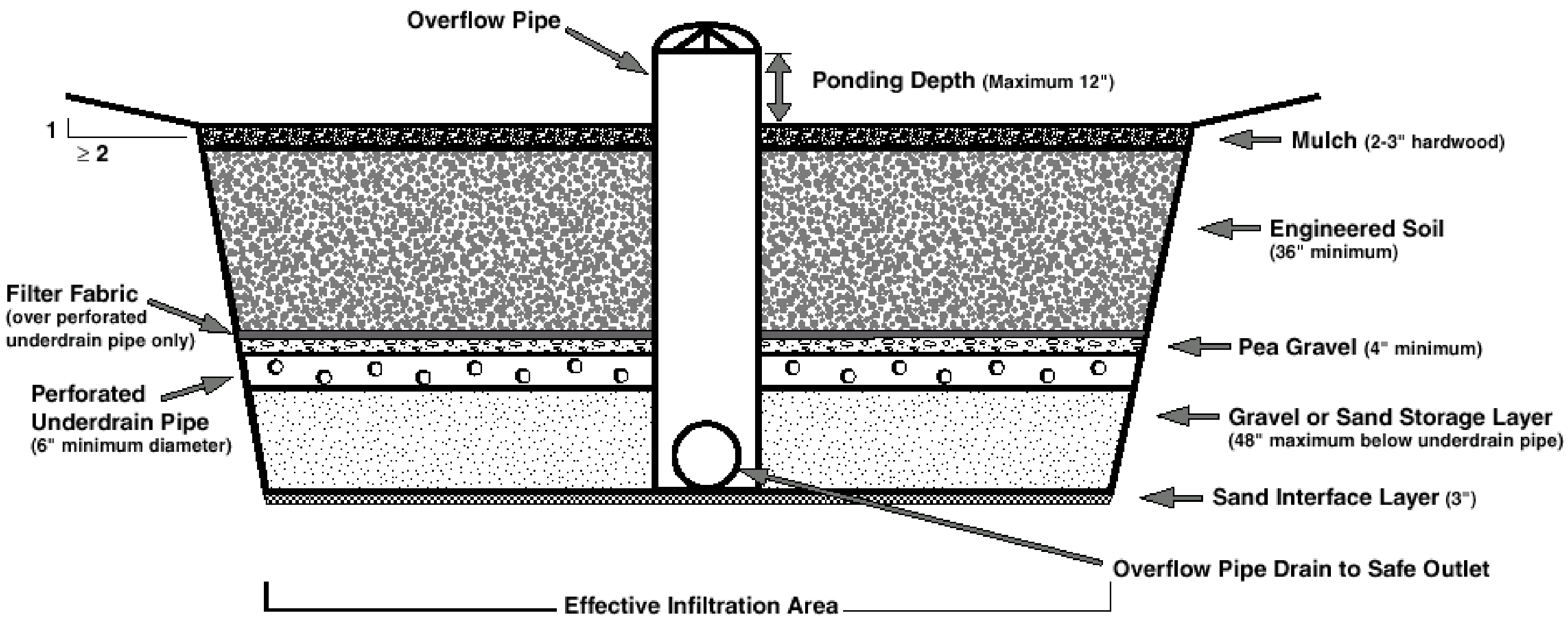


Figure 3. Example of **Bioretention Device – cross-section across length of device**



Part V. Criteria

Definition: Effective Infiltration Area

Effective Infiltration Area: The area of the infiltration system that is used to infiltrate runoff, not to include the area used for site access, berms or pretreatment.

For bioretention, the effective infiltration area is considered to be the surface area of the bottom of the excavated hole, at the native soil interface.

Part V. Criteria

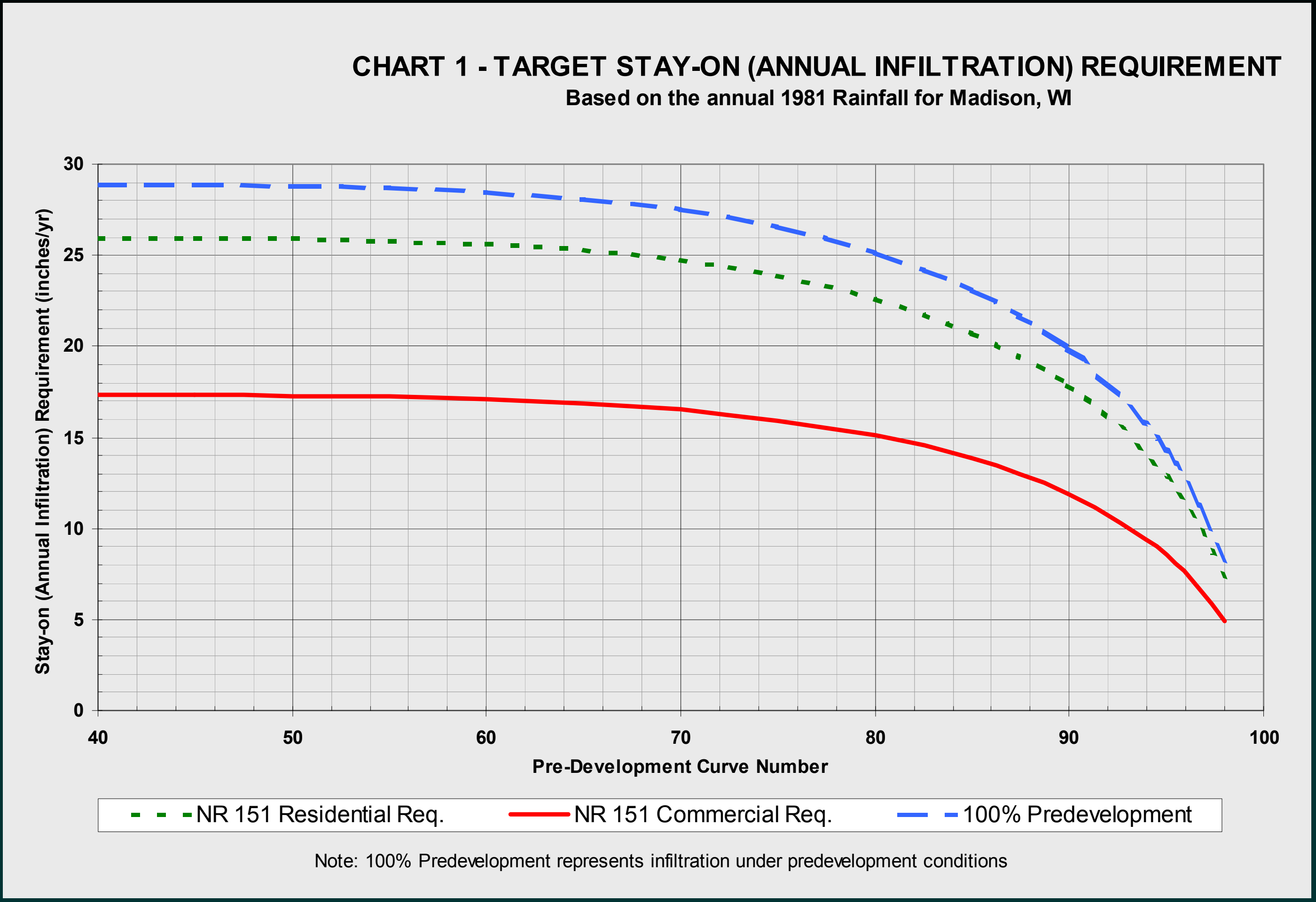
Definition: Target Stay-on Depth

Target Stay-on Depth: The amount of infiltration required on an average annual basis.

It is the portion of the annual rainfall (inches) on the development site that must be infiltrated on an annual basis to meet the infiltration goal.

Part V. Criteria

B.2. Design: Target Stay-on Depth



Part V. Criteria

B.3. Design: Flow Regulation

- Inflow
  - Shall be non-erosive, uniform distribution

- Overflow
  - Shall use weir or standpipe to control pond depth
  - Shall discharge to suitable conveyance via stable outlet
  - Shall restrict use of curtain drains
  - Shall meet underdrain requirements

Part V. Criteria

B.4. Design: Ponding Area

- Design pond depth shall not exceed 12 inches
- Pond draw-down time shall not exceed 24 hours
  - (Design depth) / (design draw-down rate) shall not exceed 24 hours
  - Example: 9 inches/(0.5 inches per hour) = 18 hours
- Berm slopes shall be 2H:1V or flatter

Part V. Criteria

Definition: Design Ponding Depth

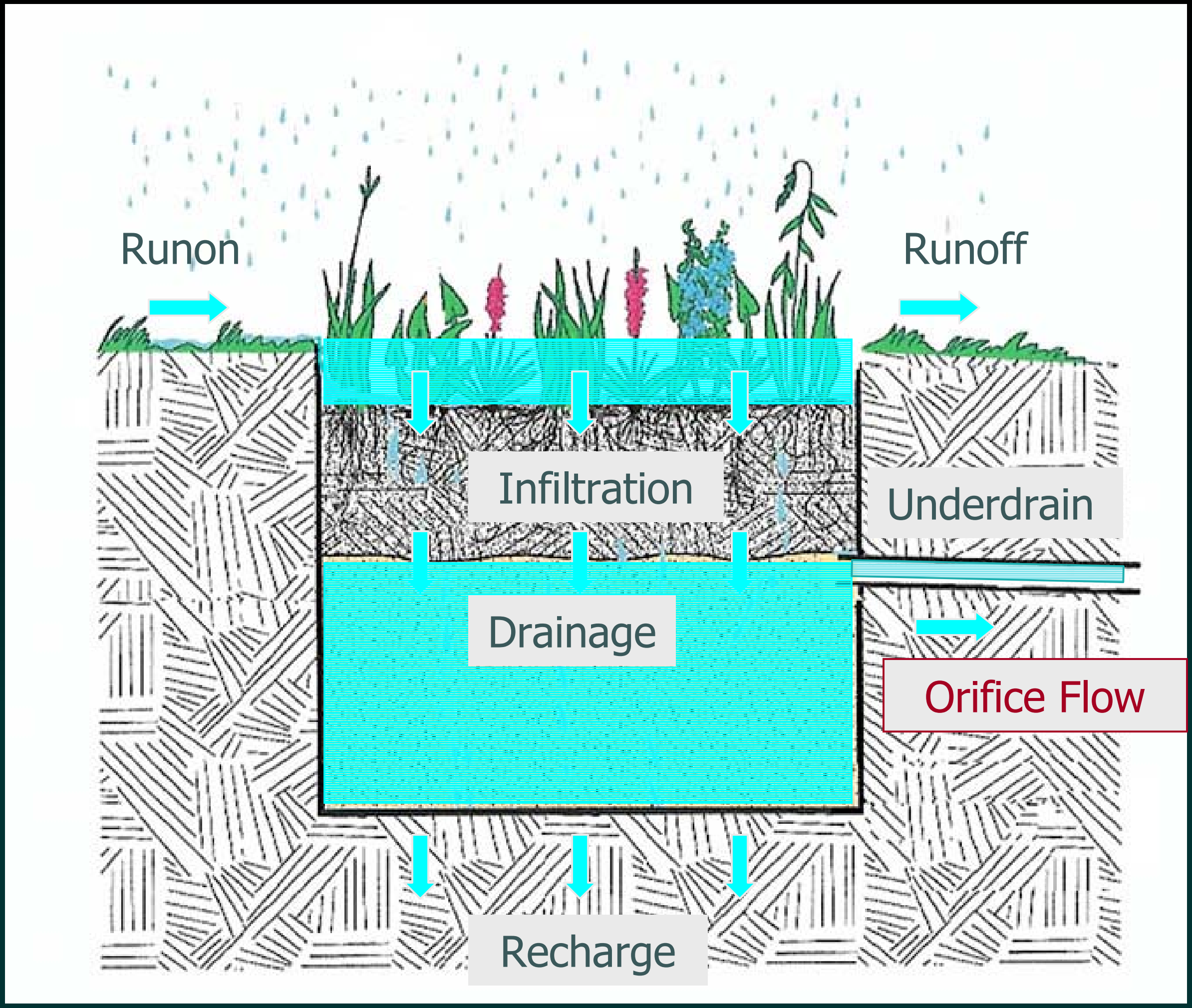
Design Ponding Depth: The distance (inches) between the top of the mulch layer and the invert of the overflow structure.

Part V. Criteria

Definition: Design Draw-down Rate

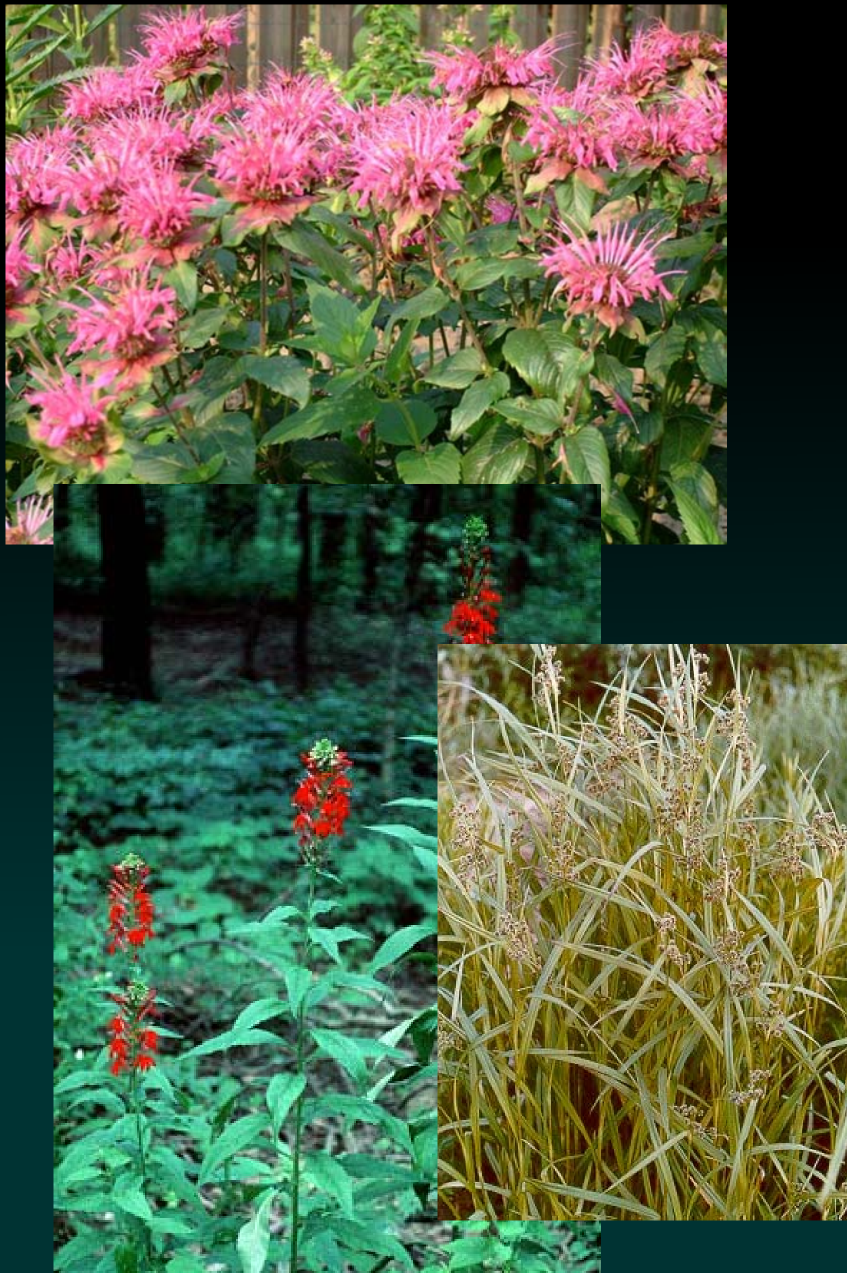
Design Drawdown Rate. The rate (inches/hour) at which water drains from the ponding area through a combination of infiltration into the native soil and loss through the underdrain.

Draw-down of Ponding Zone



Part V. Criteria
B.5. Design: Vegetation & Mulch

- Planting plan
  - Shall prepare & follow a plan
    - Identify hydrologic zones & other conditions
  - Select plants
    - Shall use native herbs, shrubs, trees
    - Consider salt tolerance
    - Shall use rootstock and plugs
    - Do not use seeds or turf grass

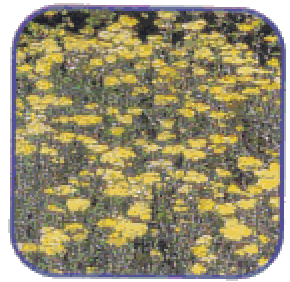


Raingarden Plants

- Most commonly prairie species, shrubs
- Facultative Wetland to Facultative Upland
- Plant diverse mix
- See Standard for plant references
- Plan for some necessary replacement

1 Butterfly Milkweed
(Asclepias tuberosa)
Height: 1-2 feet
Space: 1 foot
Blooms: May - June

2 Moonshine Yarrow
(Archillea filipendula 'Moonshine')
Height: 2-3 feet
Space: 18 inches
Blooms: June to frost



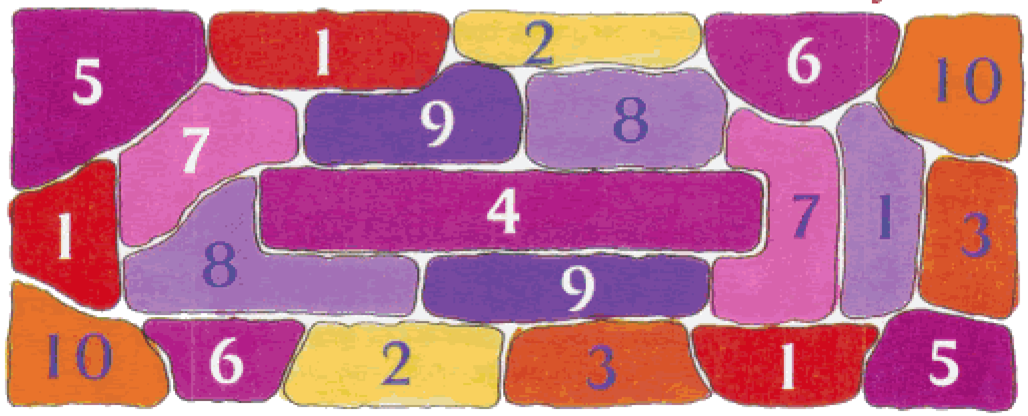
3 Black-Eyed Susan
(Rudbeckia hirta)
Height: 1-2 feet
Space: 1 foot
Blooms: May to frost

MAPLEWOOD
Together We Can

10 Stella de Oro Daylily
(Hemerocallis 'Stella de Oro')
Height: 15 inches
Space: 15 inches
Blooms: May to frost

4 Marsh Milkweed
(Asclepias incarnata)
Height: 3-5 feet
Space: 1 foot
Blooms: June through August

Butterflies and Friends Garden Layout



9 New England Aster
(Aster novae-angliae)
Height: 4-5 feet
Space: 2 feet
Blooms: Midsummer to frost

5 Fire King Yarrow
(Achillea millefolium 'Fire King')
Height: 1-2 feet
Space: 1 foot
Blooms: May to frost

8 Bee Balm; Bergamot
(Monarda fistula)
Height: 2-3 feet
Space: 18 inches
Blooms: late May to Fall

7 Joe Pye
(Eupatorium maculation)
Height: 4-5 feet
Space: 2 feet
Blooms: June - frost

6 Blazing Star
(Liatris spicata)
Height: 2-3 feet
Space: 18 inches
Blooms: June to frost

Bonestroo
Rosene
Anderlik &
Associates
Engineers & Architects
Garden & Brochure Design

Part V. Criteria

B.5. Design: Vegetation & Mulch

- Plant placement
  - Shall use lower density and maintain mulch layer if source areas are non-residential
  - Shall not use woody vegetation at inflow points
  - Shall mulch soil left to settle

- Surface mulch layer
  - Shall use 2-3 inches of clean, aged hardwood mulch

Part V. Criteria

B.6. Design: Engineered Soil Planting Bed

- Mix to provide nutrients, water retention and drainage necessary for plants
- Can provide additional storage in facility
- Depth dependent on rooting depth of plants & pollution attenuation

Part V. Criteria

B.6. Design: Engineered Soil Planting Bed

- Surface area - determine using approved model
- Slope - not to exceed 1%
- Depth - minimum 36”
  - Includes 4” pea gravel layer if storage zone is gravel
- Engineered soil mixture
  - Mixture of 40% sand, 20-30% topsoil, 30-40% compost
  - pH 5.5 - 6.5
  - Plant friendly: adequate nutrients, non-toxic
  - No roots, stumps, etc.

Part V. Criteria

B.6. Design: Engineered Soil Planting Bed

- Soil Mix Components
  - ♦ Sand: pre-washed, coarse silica
  - ♦ Topsoil: USDA sandy loam, loamy sand or loam
    - Verification by lab test or competent professional
  - ♦ Compost shall meet DNR Specification 100 (Compost)

Part V. Criteria

B.6. Design: Engineered Soil Planting Bed

- Compost (DNR Specification 100)
  - Compost must meet listed specifications
  - Must be well composted (mature)
  - Noxious weed seeds shall be minimized
  - Source materials not restricted. Must meet:
    - Class A pathogen requirements (NR 204)
    - High quality pollutant concentrations (NR 204)

Part V. Criteria

B.6. Design: Engineered Soil Planting Bed

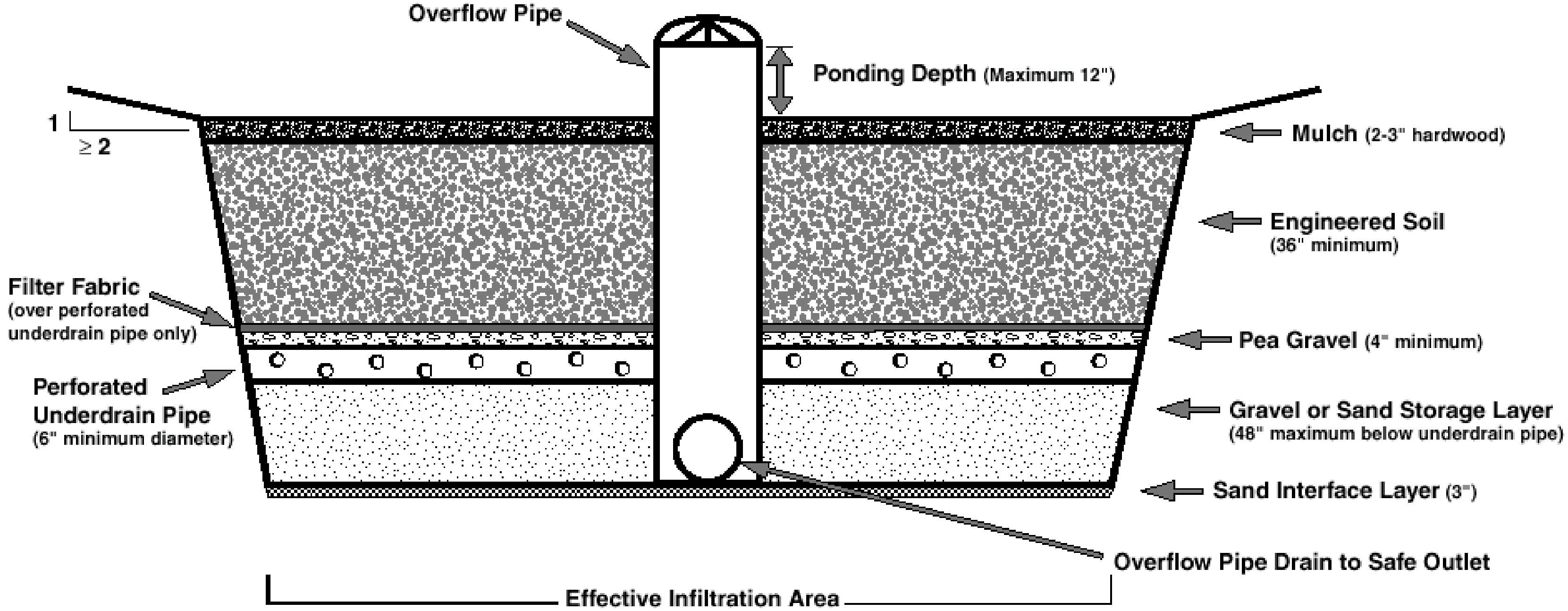
- Compost (DNR Specification 100)
  - Bio-solids (BS)
    - May use as source; must be composted (CBS)
    - Currently no CBS produced in Wisconsin
    - BS must meet Exceptional Quality (EQ) Criteria in NR 204.03(19)
    - Ask producer documentation; contact DNR
    - NR 204 does not govern material derived from EQS

Part V. Criteria

B.6. Design: Engineered Soil Planting Bed

- Compost (DNR Specification 100)
  - Weed seeds and pathogens in compost can be effectively reduced by using a composting method that maintains a minimum critical temperature (55 degrees Celcius) for at least 3 consecutive days for compost piles and for at least 15 consecutive days for turned windrow systems

Figure 3. Example of **Bioretention Device – cross-section across length of device**



Part V. Criteria

B.7. Design: Storage Layer

- Water in storage layer can not exit device via under-drain
- Water in storage layer must infiltrate into the native soil
- Storage layer reduces loss through under-drains.

Part V. Criteria

B.7. Design: Storage Layer

- Required if design infiltration rate < 3.6 in/hr
  - Design infiltration rate is for native soil
  - Determined using DNR Standard 1002

- Use washed, coarse sand or #2 aggregate

Part V. Criteria

B.7. Design: Storage Layer

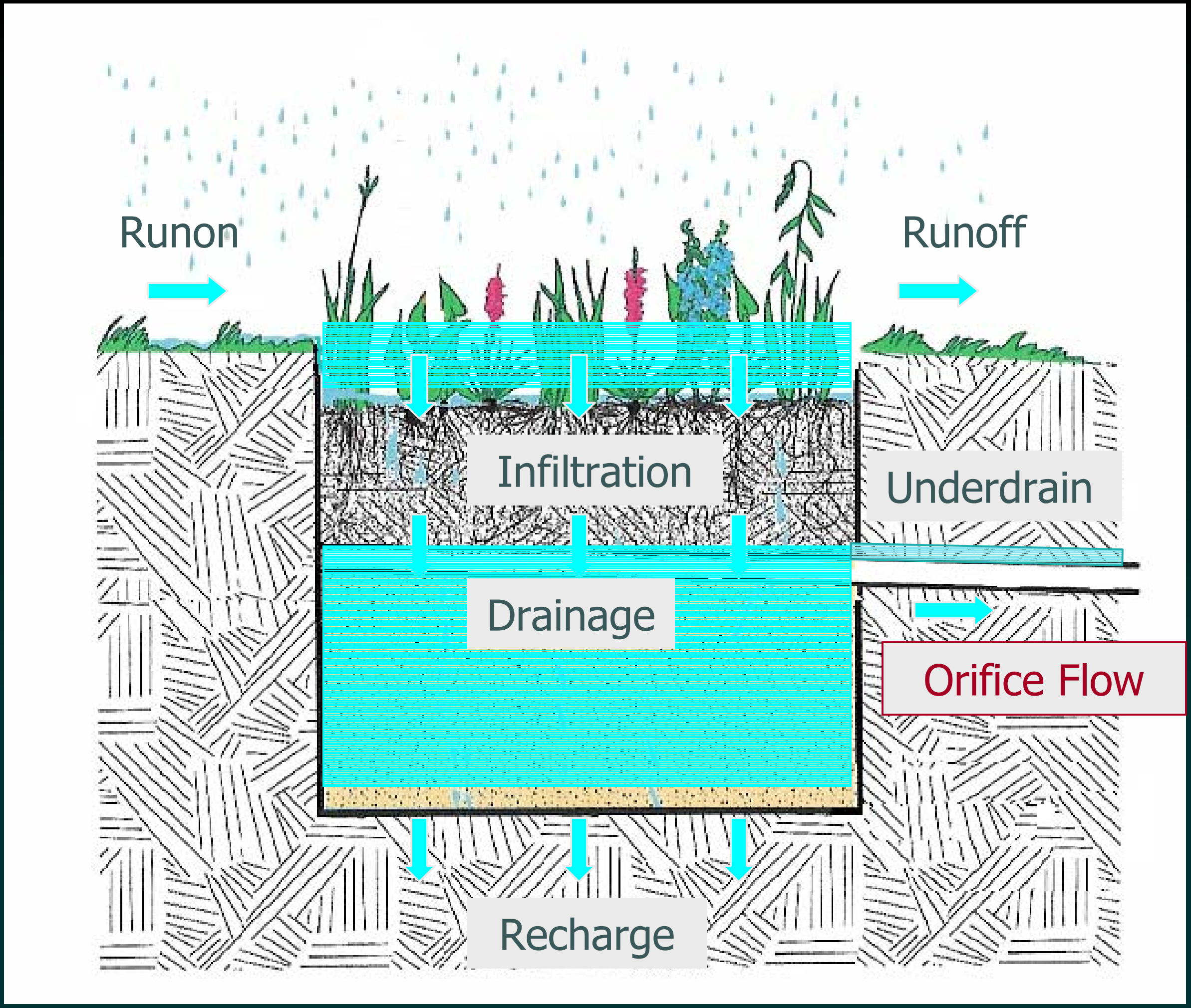
- Storage depth is limited by 2 factors
- Depth may not exceed 48”
- Total draw-down time for a fully saturated device may not exceed 72-hours

Part V. Criteria

Definition: Fully Saturated

Fully Saturated. A bioretention device that has a saturated storage layer, a saturated engineered soil layer and water ponded to the invert of the overflow pipe in the ponding area.

Fully Saturated Device



Part V. Criteria

Definition: Total Device Drain Time

Total Device Drain Time: The time it takes water to drain from a fully saturated bioretention device.

This includes the time it takes to drain water from the ponding area, the engineered soil and the storage layer. Water from the ponding area and engineered soil exit via a combination of the underdrain and native soil. Water from the storage layer exits only via the native soil.

Part V. Criteria

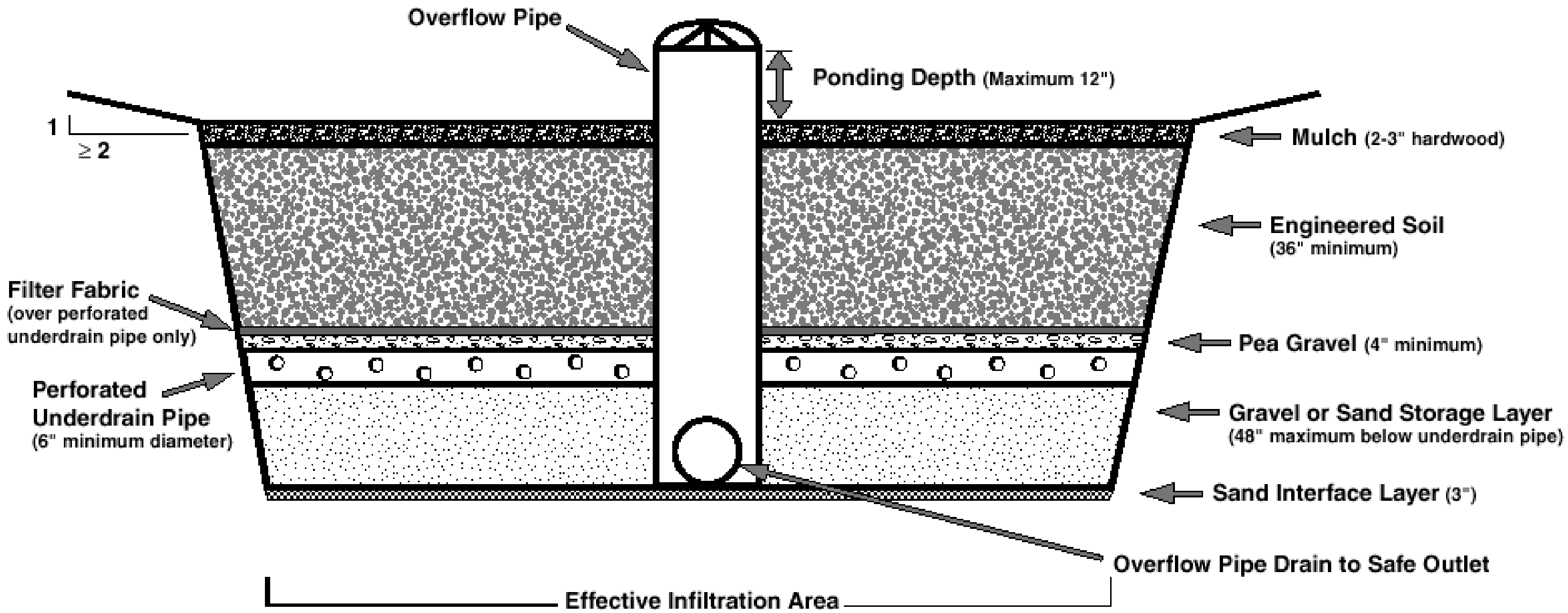
Design: Storage Layer

- Consideration U. Helpful equations to determine allowable storage layer thickness:
  - $H_P = D_P/(K_U + K_N)$
  - $H_{ES} = (D_{ES} * P_{ES})/(K_U + K_N)$
  - $D = (72 \text{ hours} - (H_P + H_{ES})) * K_N$
  - $T_{SL} = D/P_{SL}$

Example Maximum Storage Layer Depths

Table 5. Sample storage layer thicknesses (inches) that meet the 72-hour total device drain time								
		Kn (in/hr)						
Pond Depth	**Ku+Kn**	**0.07**	**0.11**	**0.13**	**0.24**	**0.5**	**1.63**	**3.6**
(in)	**(in/hr)**	***Storage Layer Thickness (inches)***						
6	0.24	***1***	***2***	***3***	***6***			
6	0.5	***9***	***14***	***16***	***29***	***48***		
6	1.63	***13***	***21***	***25***	***45***	***48***	***48***	
6	3.6	***14***	***23***	***27***	***48***	***48***	***48***	***48***
9	0.5	***7***	***12***	***14***	***25***	***48***		
9	1.63	***13***	***20***	***24***	***44***	***48***	***48***	
9	3.6	***14***	***22***	***26***	***48***	***48***	***48***	***48***
12	1.63	***12***	***20***	***23***	***43***	***48***	***48***	
12	3.6	***14***	***22***	***26***	***48***	***48***	***48***	***48***

Figure 3. Example of **Bioretention Device – cross-section across length of device**



Part V. Criteria

B.8. Design: Underdrain

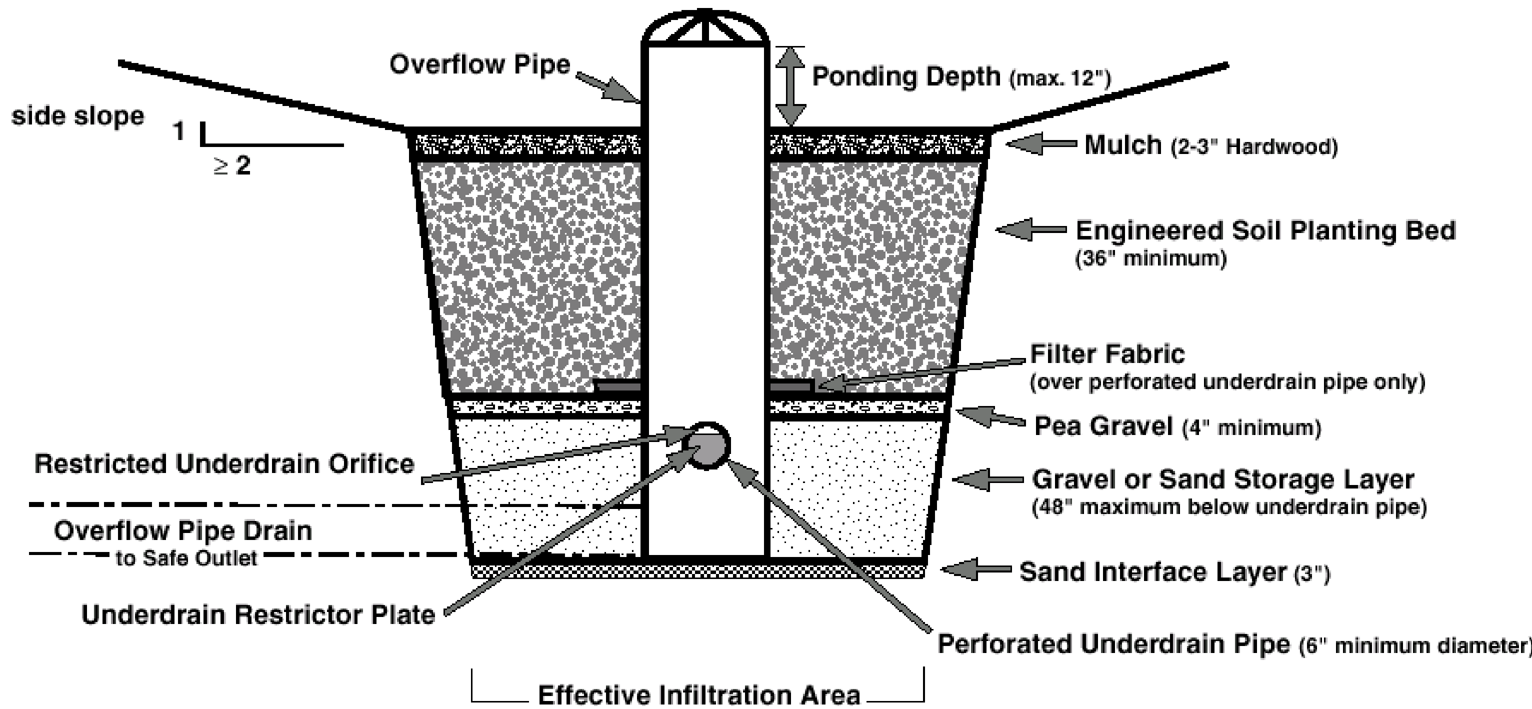
- Necessary to Control Duration of Ponding
- Limit orifice opening to reduce amount of “lost” potential recharge
- Design so that flow rate can be retrofitted

Part V. Criteria

B.8. Design: Under-drain

- Generally required
  - Exceptions: unsuitable outlet, low failure risk
- Pipe diameter: 6” minimum
- Location: top of storage layer
- Flow rate = (Design draw-down) - (design infiltration rate)
- Adjustable, accessible restrictor plate

Figure 2. Example of **Bioretention Device** – **cross-section across width of device**



Part V. Criteria

B.8. Design: Under-drain

- Pipe protection required
  - Filter fabric, filter sock, pea gravel
- Clean-out port required
- Discharge to existing drainage system
  - Install check-valve if back-flow possible.

Part V. Criteria

B.9. Design: Interface Layer

- Enhances infiltration
- Required if native soil infiltration < 3.6”/hr
- Mix 3” sand into 2-4” native soil at bottom of facility

Part V. Criteria

B.10. Design: Design Infiltration Rate

The design infiltration rate (native soil infiltration rate) shall not exceed the rate determined in accordance

with

DNR Conservation Practice Standard 1002:

Site Evaluation for Stormwater Infiltration

Part V. Criteria

B.11. Design: Observation Wells

- Observation well required if there is no underdrain
- 1 well/ 1,000 sq. ft. effective infiltration area
- Other requirements
  - Min. diameter 6”
  - Invert elevation; footplate; protective cap

Part V. Criteria

C. Construction Sequencing & Oversight

- A person trained and experienced in construction, operation & maintenance of infiltration devices shall be responsible for construction of the device
  - Keep construction site erosion out of device
  - Avoid wet conditions during construction
  - Avoid compaction; remediate if needed
  - Place soil carefully & mulch prior to planting

Part VII. Plans & Specifications

- Shall be prepared for each site
- Plans
  - Materials; construction processes & sequence; location, size and elevations of all components
  - Plan, longitudinal & cross-section views
- Specifications
  - Contractor responsibilities
  - Materials certifications
  - Planting bed and plant material specifications

Part VIII. Operation/Maintenance

- O&M plan required for inspection, operation & maintenance
  - inspection frequency
  - sediment, erosion, trash
  - plant health, mulch replacement
  - inlet/outlet maintenance; under-drains
  - Do not dump snow directly on planting bed

Part VI. Considerations

- C. May use as filtration & recovery
- D. Does not treat chlorides
- E. Reduce tributary area size to 0.5 - 1 acre if it is primarily impervious (roof, parking)
- F. Counter loss of CEC; sodium accumulation
- H. Consider pre-treatment
- K. If reduce surface area, increase depth of ponding zone & storage layer to compensate

Part VI. Considerations

- L. Technical note
- P. Optimal pond depth is 6-9”
- Q. Choice of plant community

  Forest, forest fringe, ornamental, meadow
- W. May reconfigure storage layer as long as storage volume is not lessened

Sizing a Bioretention Device Using RECARGA

John Pfender

DNR Water Resources Specialist

Post-Construction Stormwater Management Workshop

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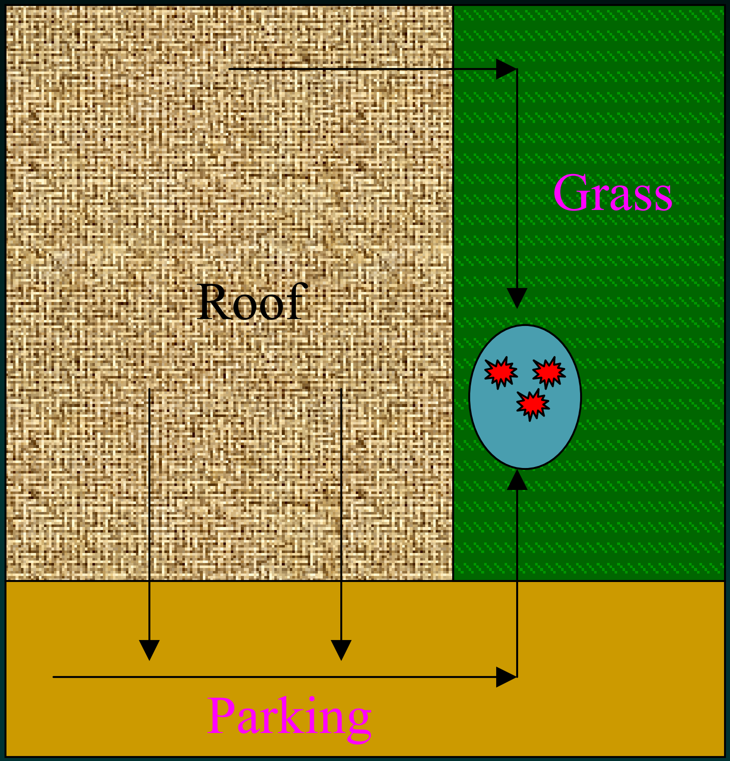
Site Characteristics

Site Layout



Site Specifics

- Commercial Site
- Tributary area characteristics
  - 1 acre
  - Pre-development CN = 76
  - Will be 90% impervious
  - Pervious CN will be 80
  - Design Infiltration Rate = 0.5”/hr
    - Sandy loam soils

Sizing Tools

- Technical Note
  - Approved Sizing Tools
    - Target Stay-on Chart
    - RECARGA Model
  - Others with prior approval
  - Bioretention Worksheet & Nomograph
    - Not approved for final sizing
    - For planning only

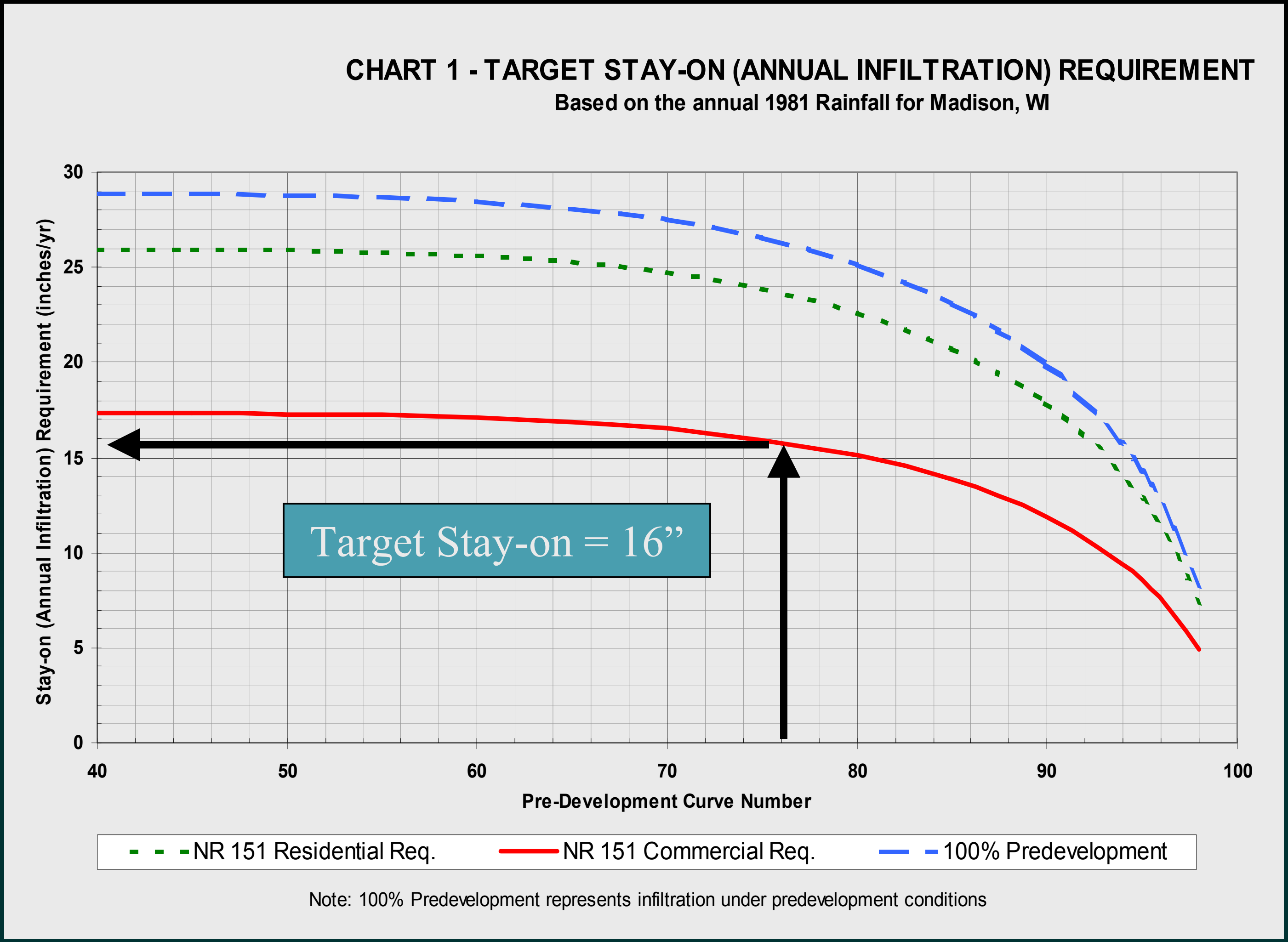
Getting Started

- Download the Technical Note
  - Includes the Stay-on Target Chart
- Download RECARGA
  - RECARGA Folder
  - User's Manual

Determine Target Stay-On

Open Target Stay-on Chart
and find the Stay-on Depth
required to meet the performance standard

Example Design Problem: Target Stay-On Depth



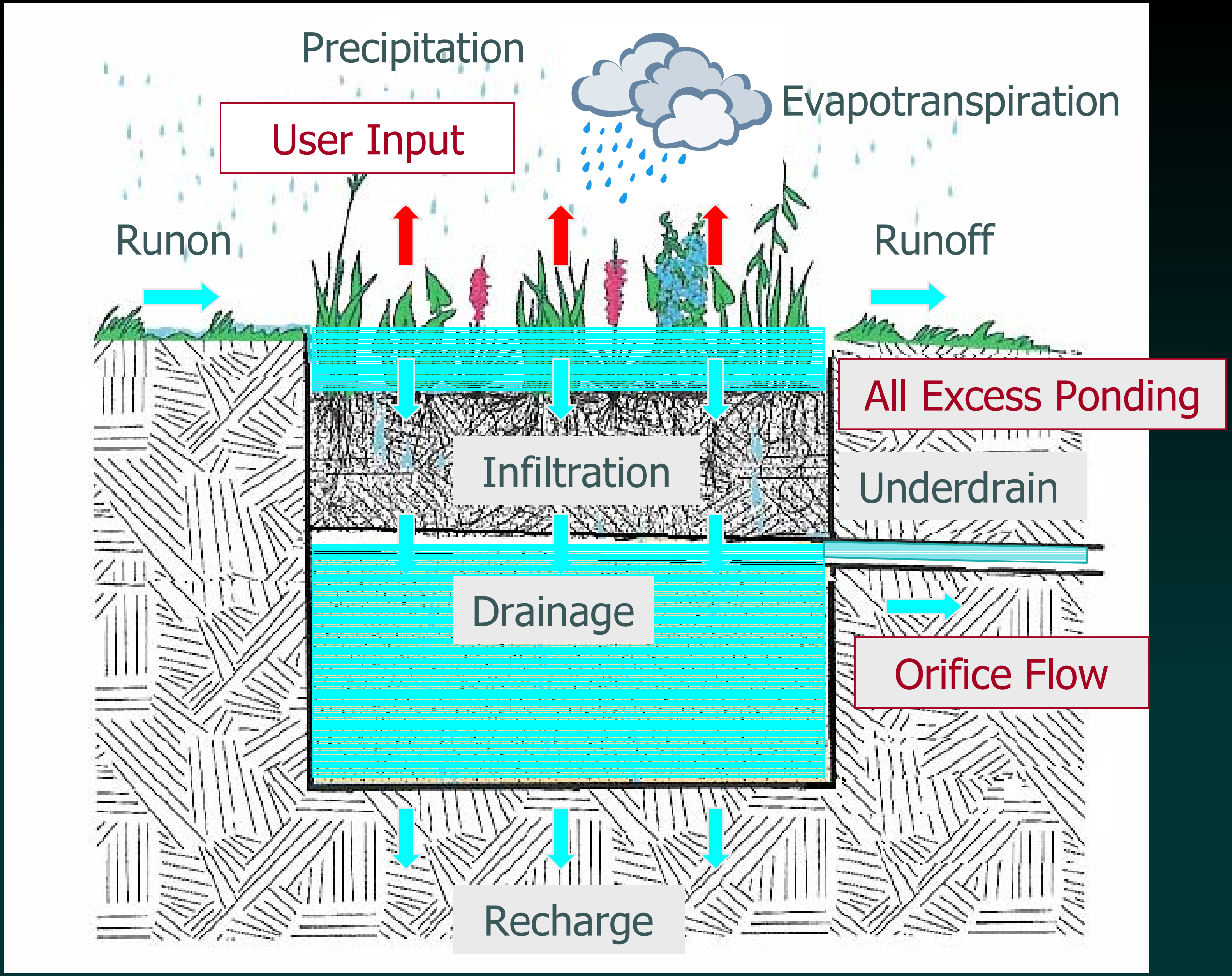
Determine Effective Infiltration Area

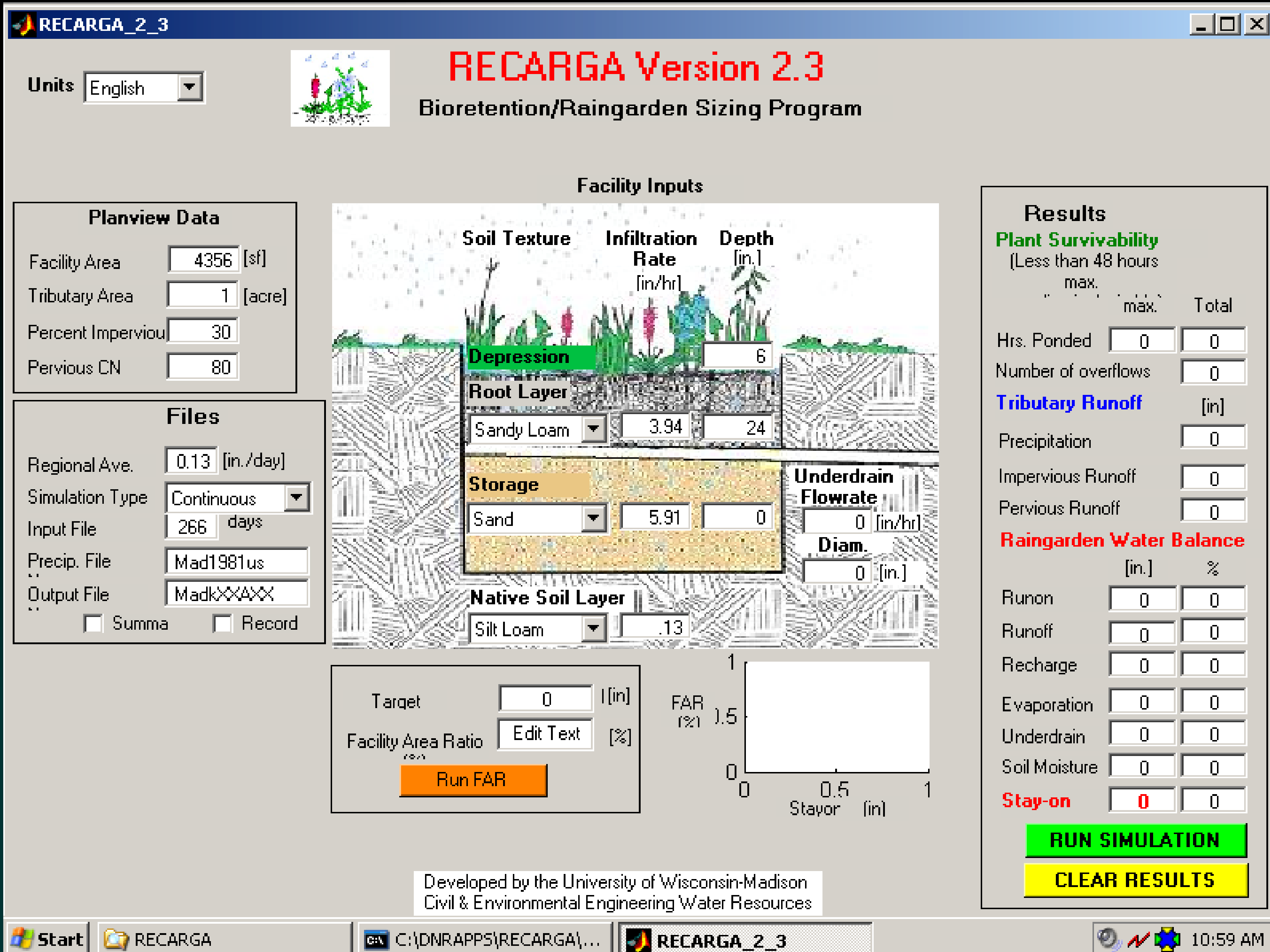
Access RECARGA Folder

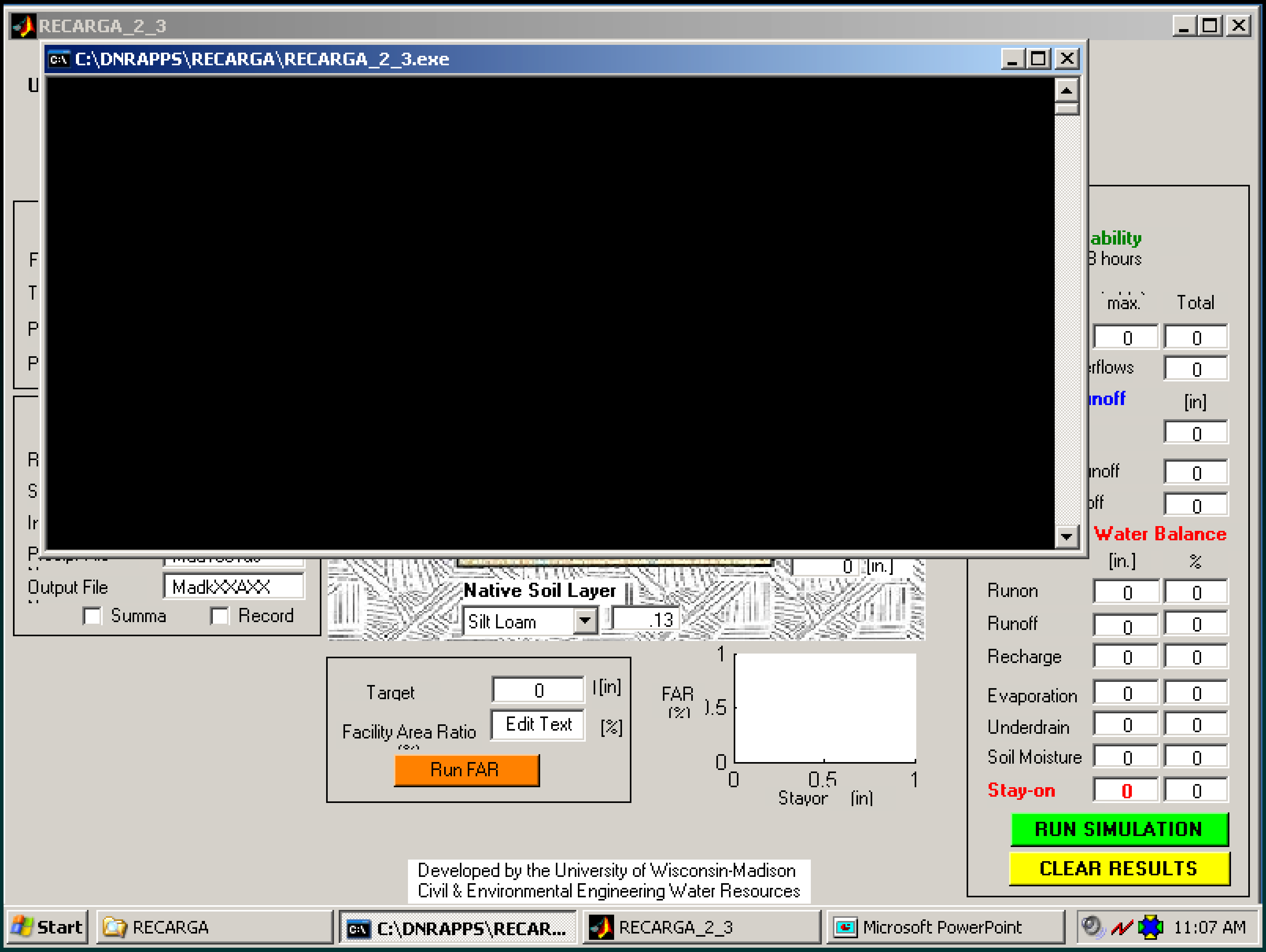
Find and click on Model:

RECARGA_2_3.exe

RECARGA Model Basics




RECARGA_2_3
Units
English
RECARGA Version 2.3
Bioretention/Raingarden Sizing Program
Facility Inputs
Planview Data
Facility Area
4356
[sf]
Tributary Area
1
[acre]
Percent Imperviou
30
Pervious CN
80
Files
Regional Ave.
0.13
[in./day]
Simulation Type
Continuous
Input File
266
days
Precip. File
Mad1981us
Output File
MadkXXAXX
Summa
Record
Soil Texture
Infiltration Rate [in/hr]
Depth [in.]
Depression
6
Root Layer
Sandy Loam
3.94
24
Storage
Sand
5.91
0
Underdrain Flowrate
0
[in/hr]
Diam.
0
[in.]
Native Soil Layer
Silt Loam
.13
Target
0
[in]
Facility Area Ratio
Edit Text
[%]
Run FAR
FAR (%)
Stayor [in]
Results
Plant Survivability
(Less than 48 hours max.
max.
Total
Hrs. Ponded
0
0
Number of overflows
0
Tributary Runoff
[in]
Precipitation
0
Impervious Runoff
0
Pervious Runoff
0
Raingarden Water Balance
[in.]
%
Runon
0
0
Runoff
0
0
Recharge
0
0
Evaporation
0
0
Underdrain
0
0
Soil Moisture
0
0
Stay-on
0
0
RUN SIMULATION
CLEAR RESULTS
Developed by the University of Wisconsin-Madison
Civil & Environmental Engineering Water Resources
Start
RECARGA
C:\DNRAPPS\RECARGA\...
RECARGA_2_3
10:59 AM


RECARGA_2_3
C:\DNRAPPS\RECARGA\RECARGA_2_3.exe
Output File
MadkXXAXX
Summa
Record
Native Soil Layer
Silt Loam
.13
Target
0
[in]
Facility Area Ratio
Edit Text
[%]
Run FAR
FAR
Stayor
[in]
Water Balance
[in.]
%
Runon
Runoff
Recharge
Evaporation
Underdrain
Soil Moisture
Stay-on
RUN SIMULATION
CLEAR RESULTS
Developed by the University of Wisconsin-Madison
Civil & Environmental Engineering Water Resources
Start
RECARGA
Microsoft PowerPoint
11:07 AM

RECARGA Modeling Routines

- "Run Simulation" Method
  - Iterative process
  - Requires 3-4 model runs @ 1-2 minutes each
  - Provides water budget information

- "Run FAR" (Facility Area Ratio) Method
  - Not iterative
  - Requires only one model run @ 10 minutes
  - No water budget

“Run Simulation” Method

Order of Operations

- Pick units (Recommend English)
- Fill in Plan View Data including Facility Area
  - Recommend start with Facility Area = 2% of Tributary Area
- Select Files (Can use defaults already listed)
- Fill in Facility Inputs
  - Be consistent with technical standard
    - Depth and thickness limitations
    - Pond draw-down not to exceed 24 hours
    - Facility drain time not to exceed 72 hours
    - Design infiltration rate from Tech. Standard 1002

Order of Operations (Continued)

- Click on “Run Simulation” Button & wait
  - Record Stay-on Achieved (Red Number)
  - Clear Results, adjust Facility Area
- Re-click on “Run Simulation” Button & wait
  - Record Stay-on Achieved (Red Number)
  - Clear Results, adjust Facility Area
- Re-run iteration if necessary

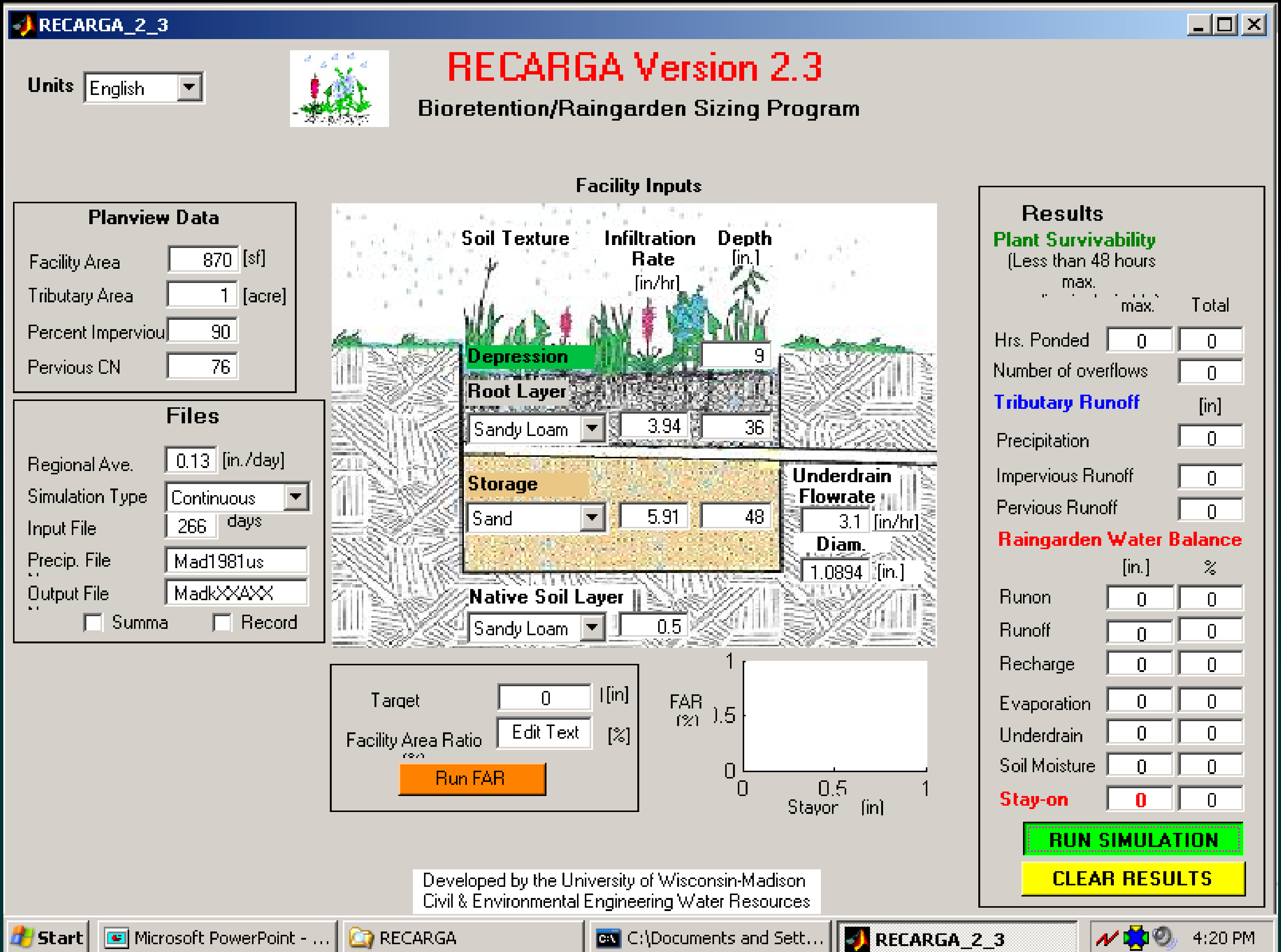
Order of Operations (Continued)

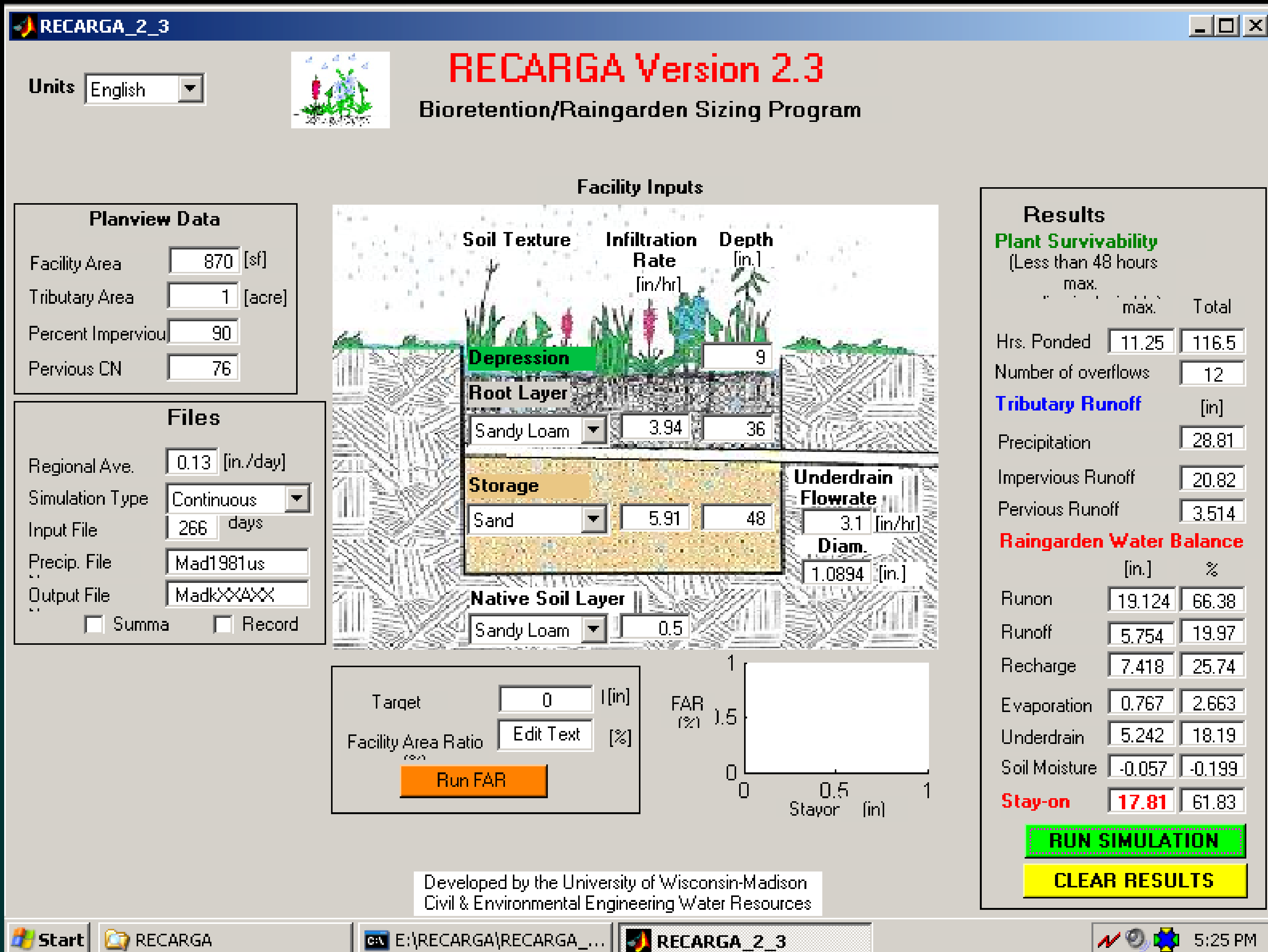
- Stop when:

  Target Stay-on result = Target Stay-on desired

- The last Facility Area used is the final solution. This is your “Effective Infiltration Area”

- You can make the surface area of the device bigger than this, but the effective infiltration area of the device (at native soil interface) must not be less than the Facility Area determined using the model


RECARGA_2_3
Units English
RECARGA Version 2.3
Bioretention/Raingarden Sizing Program
Facility Inputs
Planview Data
Facility Area 870 [sf]
Tributary Area 1 [acre]
Percent Imperviou 90
Pervious CN 76
Files
Regional Ave. 0.13 [in./day]
Simulation Type Continuous
Input File 266 days
Precip. File Mad1981us
Output File MadkXXAXX
Summa
Record
Soil Texture
Infiltration Rate [in/hr]
Depth [in.]
Depression 9
Root Layer
Sandy Loam 3.94 36
Storage
Sand 5.91 48
Underdrain Flowrate
3.1 [in/hr]
Diam.
1.0894 [in.]
Native Soil Layer
Sandy Loam 0.5
Target 0 [in]
Facility Area Ratio Edit Text [%]
Run FAR
FAR (%)
Stayor [in]
Results
Plant Survivability
(Less than 48 hours max.
max. Total
Hrs. Ponded 0 0
Number of overflows 0
Tributary Runoff [in]
Precipitation 0
Impervious Runoff 0
Pervious Runoff 0
Raingarden Water Balance
[in.] %
Runon 0 0
Runoff 0 0
Recharge 0 0
Evaporation 0 0
Underdrain 0 0
Soil Moisture 0 0
Stay-on 0 0
RUN SIMULATION
CLEAR RESULTS
Developed by the University of Wisconsin-Madison
Civil & Environmental Engineering Water Resources
Start
Microsoft PowerPoint - ...
RECARGA
C:\Documents and Sett...
RECARGA_2_3
4:20 PM


RECARGA_2_3
Units English
RECARGA Version 2.3
Bioretention/Raingarden Sizing Program
Facility Inputs
Planview Data
Facility Area 870 [sf]
Tributary Area 1 [acre]
Percent Imperviou 90
Pervious CN 76
Files
Regional Ave. 0.13 [in./day]
Simulation Type Continuous
Input File 266 days
Precip. File Mad1981us
Output File MadkXXAXX
Summa
Record
Soil Texture
Infiltration Rate [in/hr]
Depth [in.]
Depression 9
Root Layer
Sandy Loam 3.94 36
Storage
Sand 5.91 48
Underdrain Flowrate
3.1 [in/hr]
Diam.
1.0894 [in.]
Native Soil Layer
Sandy Loam 0.5
Target 0 [in]
Facility Area Ratio Edit Text [%]
Run FAR
FAR
Stayor [in]
Results
Plant Survivability
(Less than 48 hours max.
max. Total
Hrs. Ponded 11.25 116.5
Number of overflows 12
Tributary Runoff [in]
Precipitation 28.81
Impervious Runoff 20.82
Pervious Runoff 3.514
Raingarden Water Balance
[in.] %
Runon 19.124 66.38
Runoff 5.754 19.97
Recharge 7.418 25.74
Evaporation 0.767 2.663
Underdrain 5.242 18.19
Soil Moisture -0.057 -0.199
Stay-on 17.81 61.83
RUN SIMULATION
CLEAR RESULTS
Developed by the University of Wisconsin-Madison
Civil & Environmental Engineering Water Resources
Start
RECARGA
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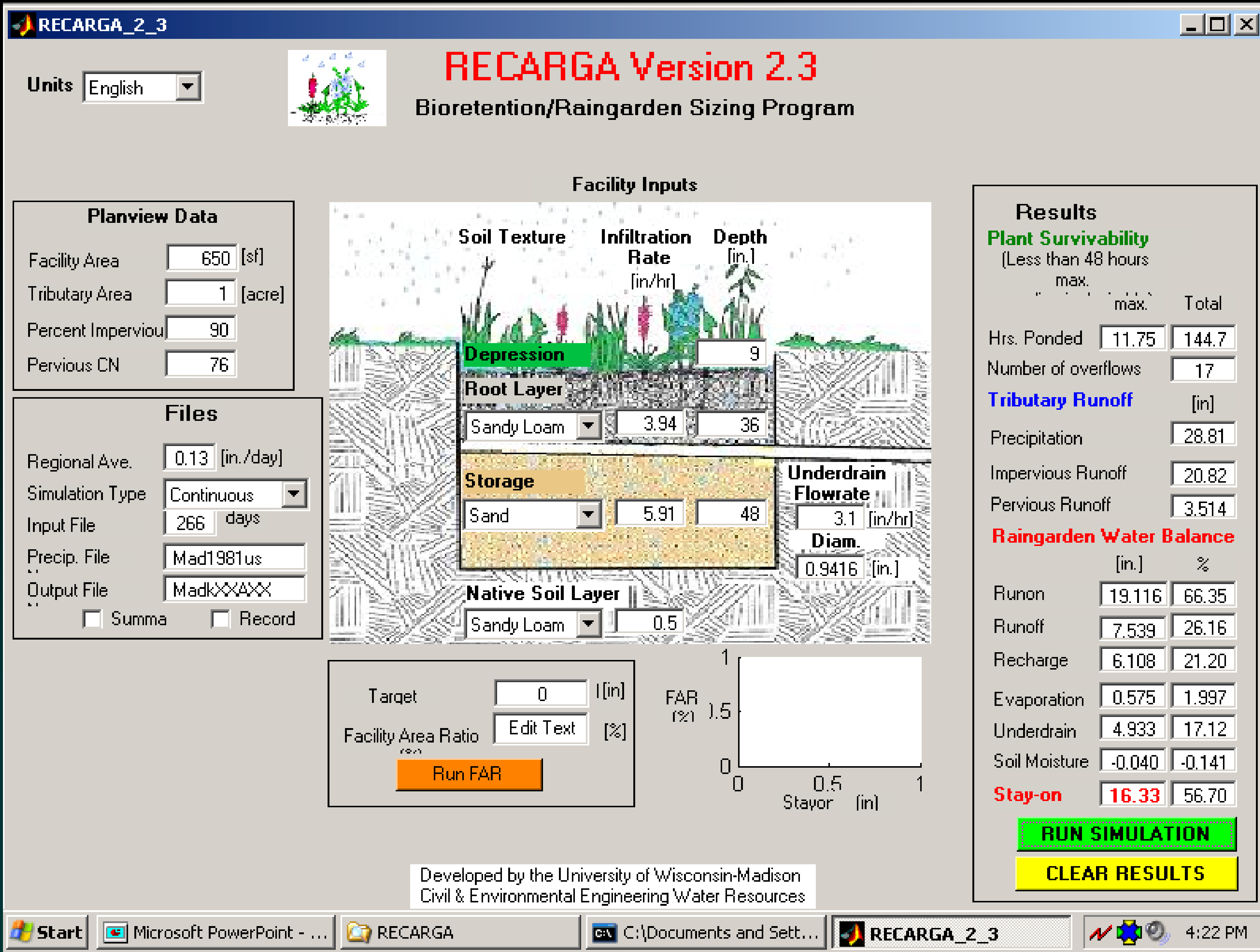
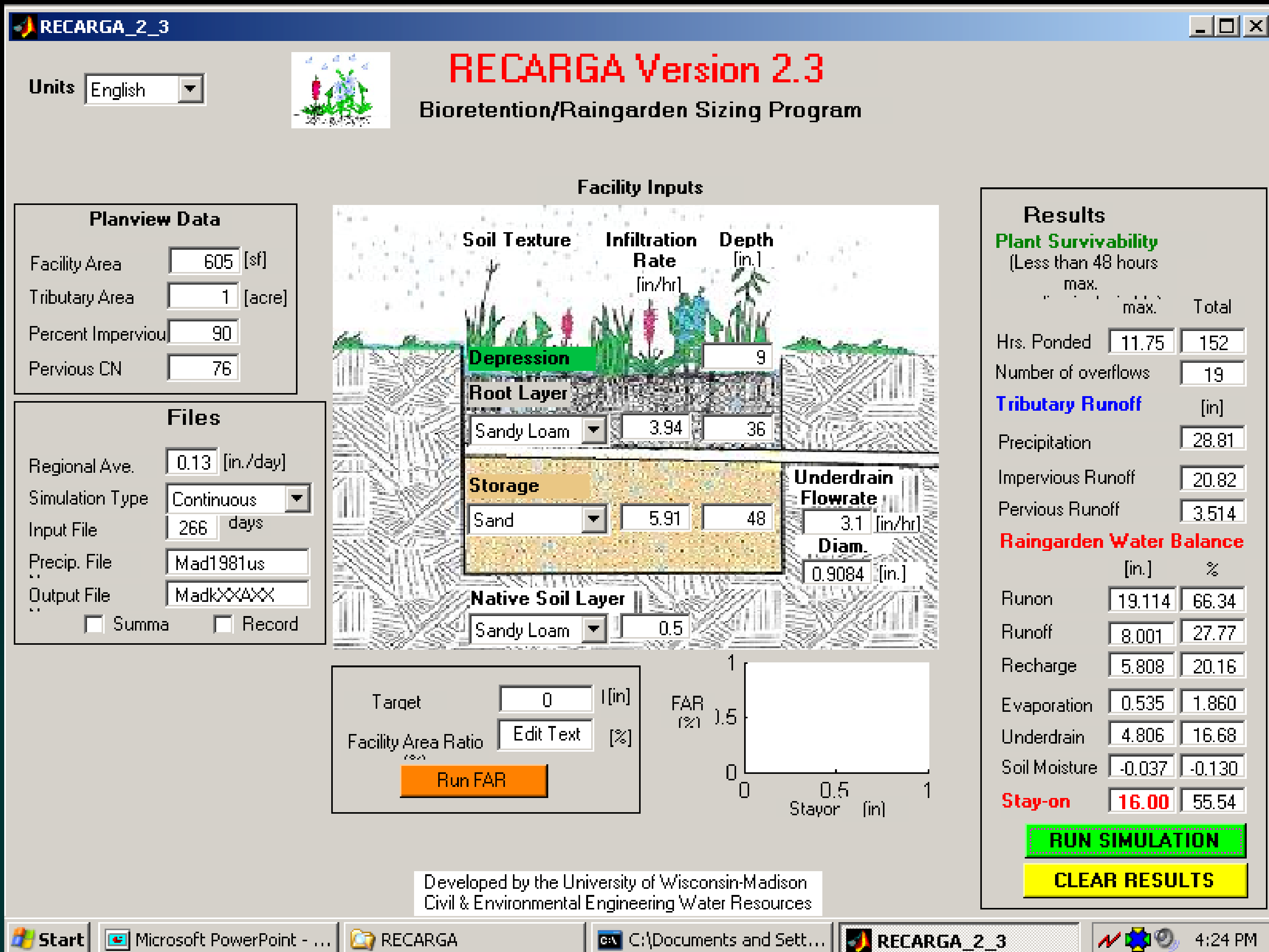
RECARGA_2_3
5:25 PM


RECARGA_2_3
Units English
RECARGA Version 2.3
Bioretention/Raingarden Sizing Program
Facility Inputs
Planview Data
Facility Area 650 [sf]
Tributary Area 1 [acre]
Percent Imperviou 90
Pervious CN 76
Files
Regional Ave. 0.13 [in./day]
Simulation Type Continuous
Input File 266 days
Precip. File Mad1981us
Output File MadkXXAXX
Summa
Record
Soil Texture
Infiltration Rate [in/hr]
Depth [in.]
Depression 9
Root Layer
Sandy Loam 3.94 36
Storage
Sand 5.91 48
Underdrain Flowrate
3.1 [in/hr]
Diam.
0.9416 [in.]
Native Soil Layer
Sandy Loam 0.5
Target 0 [in]
Facility Area Ratio Edit Text [%]
Run FAR
FAR (%)
Stayor [in]
Results
Plant Survivability
(Less than 48 hours max.
max. Total
Hrs. Ponded 11.75 144.7
Number of overflows 17
Tributary Runoff [in]
Precipitation 28.81
Impervious Runoff 20.82
Pervious Runoff 3.514
Raingarden Water Balance
[in.] %
Runon 19.116 66.35
Runoff 7.539 26.16
Recharge 6.108 21.20
Evaporation 0.575 1.997
Underdrain 4.933 17.12
Soil Moisture -0.040 -0.141
Stay-on 16.33 56.70
RUN SIMULATION
CLEAR RESULTS
Developed by the University of Wisconsin-Madison
Civil & Environmental Engineering Water Resources
Start
Microsoft PowerPoint - ...
RECARGA
C:\Documents and Sett...
RECARGA_2_3
4:22 PM


RECARGA_2_3
Units
English
RECARGA Version 2.3
Bioretention/Raingarden Sizing Program
Facility Inputs
Planview Data
Facility Area
605
[sf]
Tributary Area
1
[acre]
Percent Imperviou
90
Pervious CN
76
Files
Regional Ave.
0.13
[in./day]
Simulation Type
Continuous
Input File
266
days
Precip. File
Mad1981us
Output File
MadkXXAXX
Summa
Record
Soil Texture
Infiltration Rate [in/hr]
Depth [in.]
Depression
9
Root Layer
Sandy Loam
3.94
36
Storage
Sand
5.91
48
Underdrain Flowrate
3.1
[in/hr]
Diam.
0.9084
[in.]
Native Soil Layer
Sandy Loam
0.5
Target
0
[in]
Facility Area Ratio
Edit Text
[%]
Run FAR
FAR
1
0.5
0
0
0.5
1
Stayor
[in]
Results
Plant Survivability
(Less than 48 hours max.
max.
Total
Hrs. Ponded
11.75
152
Number of overflows
19
Tributary Runoff
[in]
Precipitation
28.81
Impervious Runoff
20.82
Pervious Runoff
3.514
Raingarden Water Balance
[in.]
%
Runon
19.114
66.34
Runoff
8.001
27.77
Recharge
5.808
20.16
Evaporation
0.535
1.860
Underdrain
4.806
16.68
Soil Moisture
-0.037
-0.130
Stay-on
16.00
55.54
RUN SIMULATION
CLEAR RESULTS
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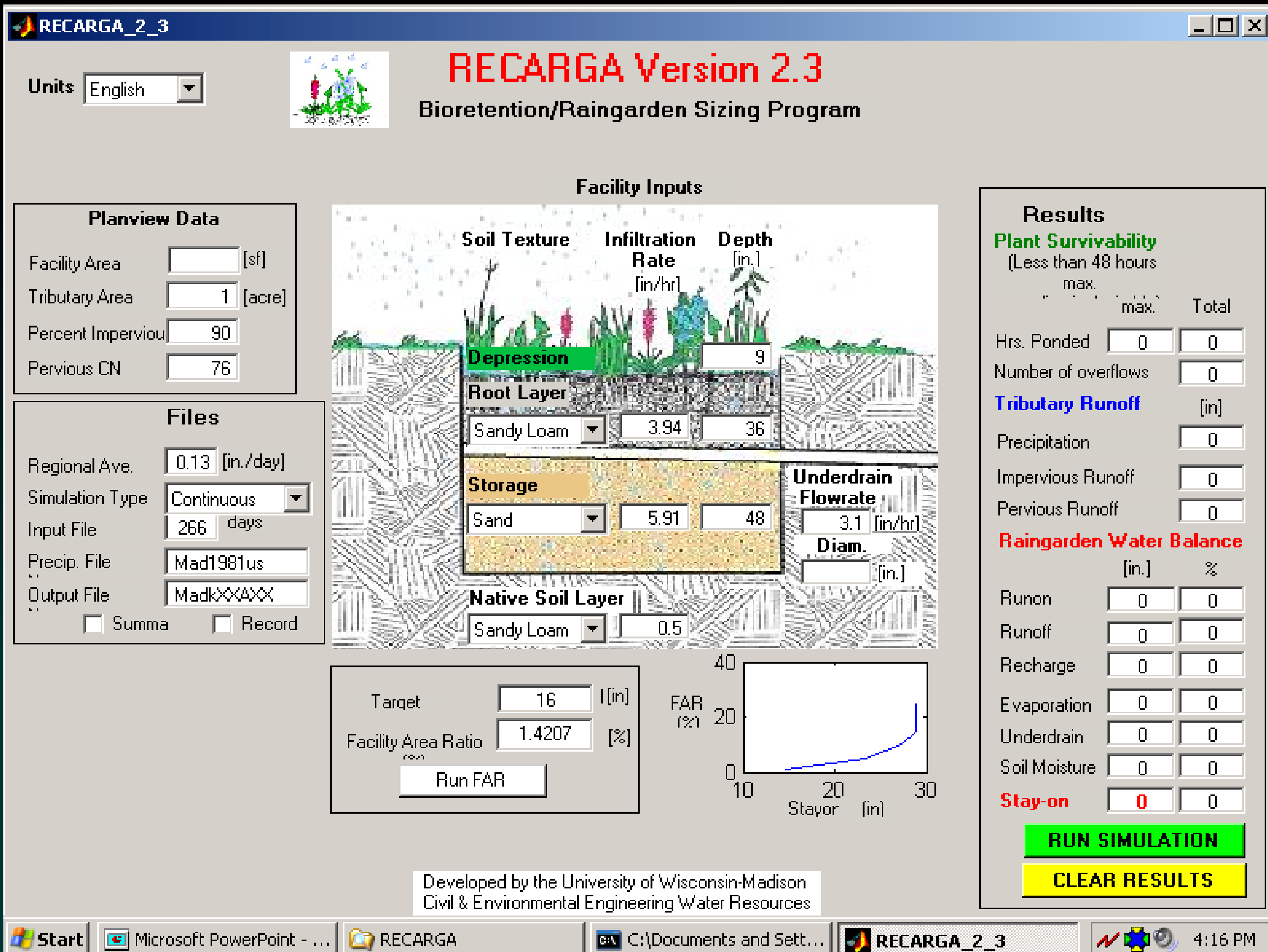
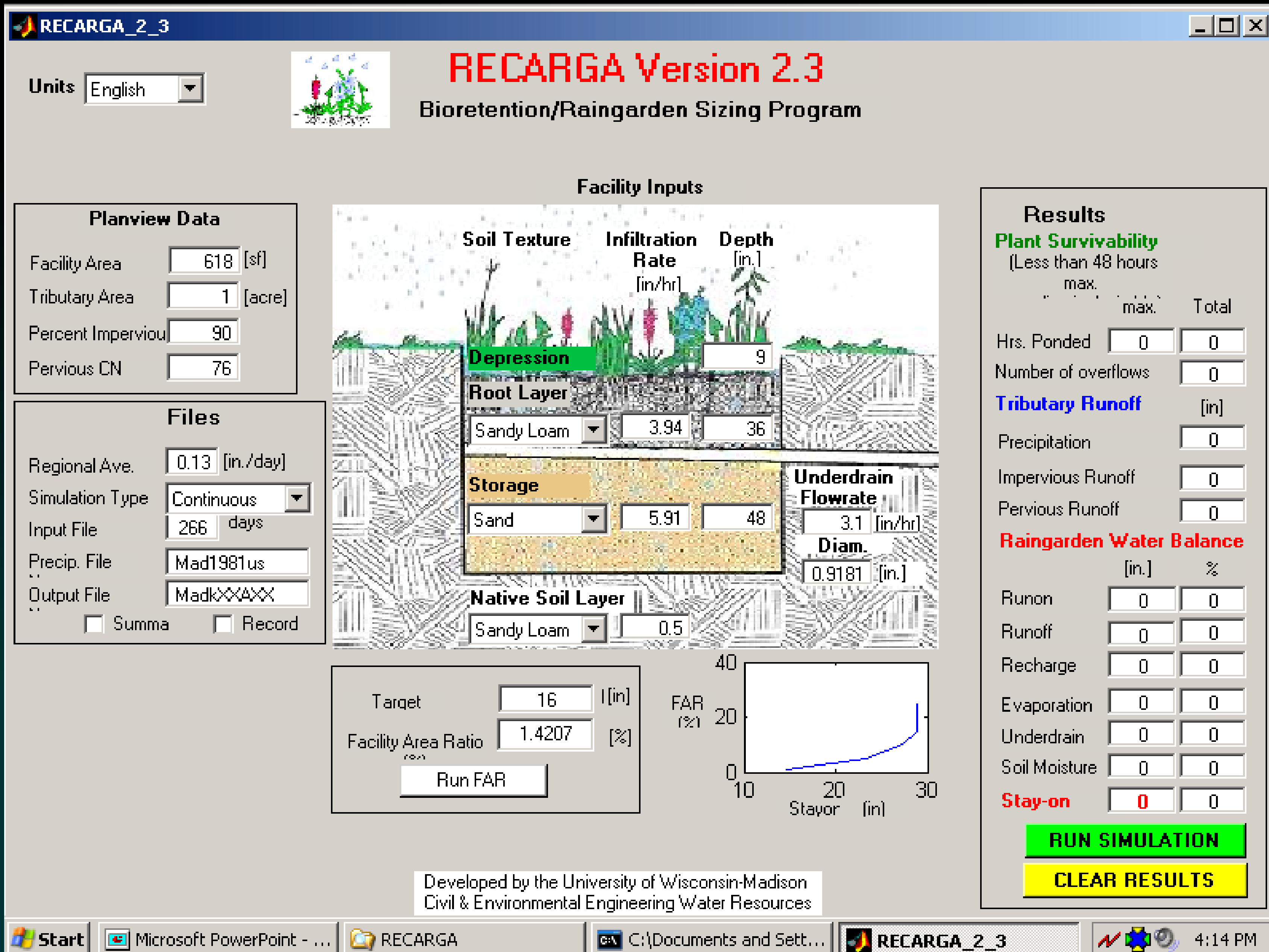
Civil & Environmental Engineering Water Resources
Start
Microsoft PowerPoint - ...
RECARGA
C:\Documents and Sett...
RECARGA_2_3
4:24 PM

“Run FAR” Method

Order of Operations for FAR Method

- Same as “Run Simulation” Method except:
  - Leave Facility Area blank
  - Enter Target Depth (bottom middle of screen)
  - Click on “Run FAR” button
  - Facility Area Ratio x Tributary Area = Facility Area
  - If you want to see the required orifice diameter, enter the Facility Area value in the Plan View Data. The orifice diameter value will appear in the appropriate box.

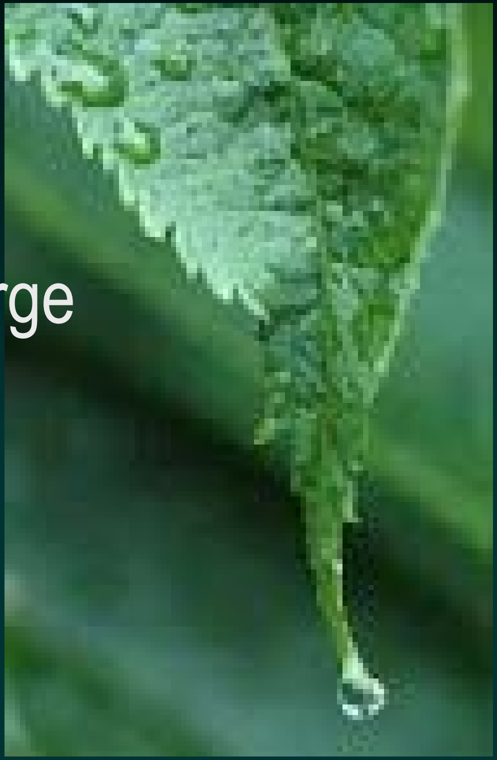

RECARGA_2_3
Units
English
RECARGA Version 2.3
Bioretention/Raingarden Sizing Program
Facility Inputs
Planview Data
Facility Area
[sf]
Tributary Area
1
[acre]
Percent Imperviou
90
Pervious CN
76
Files
Regional Ave.
0.13
[in./day]
Simulation Type
Continuous
Input File
266
days
Precip. File
Mad1981us
Output File
MadkXXAXX
Summa
Record
Soil Texture
Infiltration Rate [in/hr]
Depth [in.]
Depression
9
Root Layer
Sandy Loam
3.94
36
Storage
Sand
5.91
48
Underdrain Flowrate
3.1
[in/hr]
Diam.
[in.]
Native Soil Layer
Sandy Loam
0.5
Target
16
[in]
Facility Area Ratio
1.4207
[%]
Run FAR
FAR (%)
40
20
0
10
20
30
Stayor [in]
Results
Plant Survivability
(Less than 48 hours max.
max.
Total
Hrs. Ponded
0
0
Number of overflows
0
Tributary Runoff
[in]
Precipitation
0
Impervious Runoff
0
Pervious Runoff
0
Raingarden Water Balance
[in.]
%
Runon
0
0
Runoff
0
0
Recharge
0
0
Evaporation
0
0
Underdrain
0
0
Soil Moisture
0
0
Stay-on
0
0
RUN SIMULATION
CLEAR RESULTS
Developed by the University of Wisconsin-Madison
Civil & Environmental Engineering Water Resources
Start
Microsoft PowerPoint - ...
RECARGA
C:\Documents and Sett...
RECARGA_2_3
4:16 PM


RECARGA_2_3
Units English
RECARGA Version 2.3
Bioretention/Raingarden Sizing Program
Facility Inputs
Planview Data
Facility Area 618 [sf]
Tributary Area 1 [acre]
Percent Imperviou 90
Pervious CN 76
Files
Regional Ave. 0.13 [in./day]
Simulation Type Continuous
Input File 266 days
Precip. File Mad1981us
Output File MadkXXAXX
Summa
Record
Soil Texture
Infiltration Rate [in/hr]
Depth [in.]
Depression 9
Root Layer
Sandy Loam 3.94 36
Storage
Sand 5.91 48
Underdrain Flowrate
3.1 [in/hr]
Diam.
0.9181 [in.]
Native Soil Layer
Sandy Loam 0.5
Target 16 [in]
Facility Area Ratio 1.4207 [%]
Run FAR
FAR (%)
40
20
0
10
20
30
Stayor [in]
Results
Plant Survivability
(Less than 48 hours max.
max.
Total
Hrs. Ponded 0 0
Number of overflows 0
Tributary Runoff [in]
Precipitation 0
Impervious Runoff 0
Pervious Runoff 0
Raingarden Water Balance
[in.] %
Runon 0 0
Runoff 0 0
Recharge 0 0
Evaporation 0 0
Underdrain 0 0
Soil Moisture 0 0
Stay-on 0 0
RUN SIMULATION
CLEAR RESULTS
Developed by the University of Wisconsin-Madison
Civil & Environmental Engineering Water Resources
Start
Microsoft PowerPoint - ...
RECARGA
C:\Documents and Sett...
RECARGA_2_3
4:14 PM

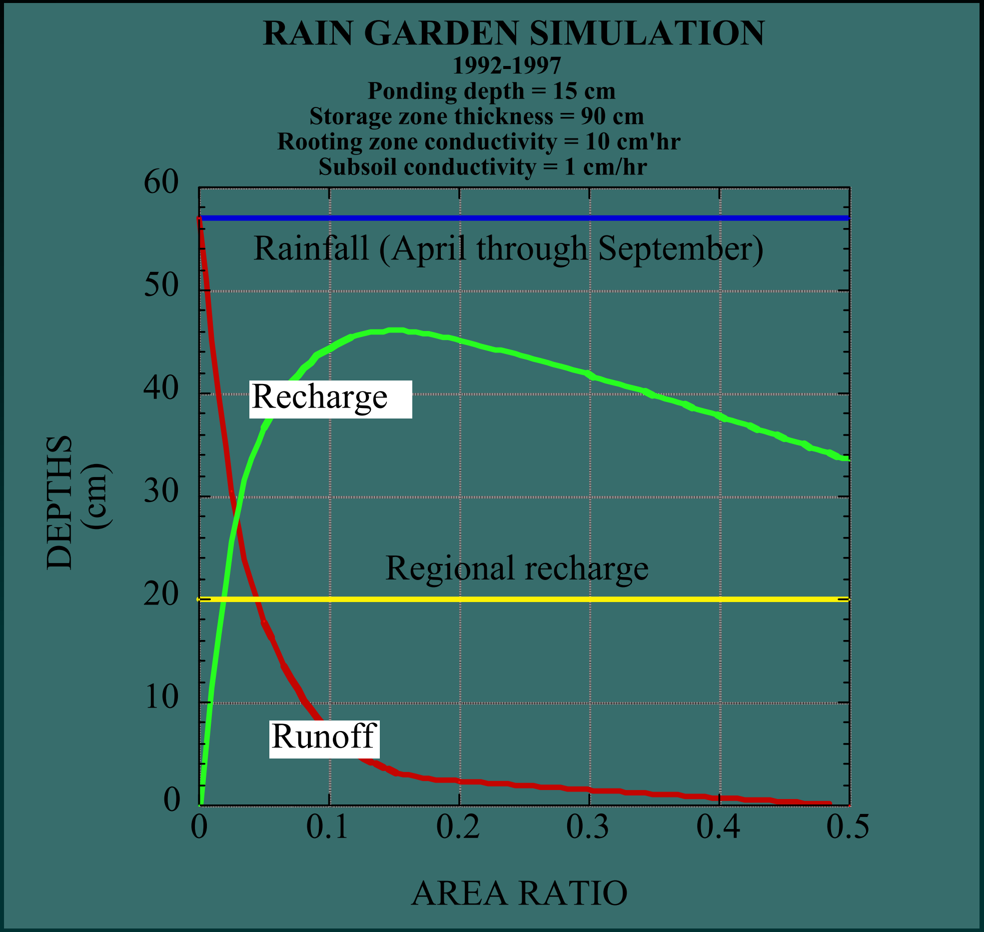
A Little Caution

You can have too much of a good thing.

If you oversize your facility, you can end up losing a lot of potential recharge to evapo-transpiration.



General Facility Area Relationships



- Declining Benefits w/ Increased Area
- Maximize % of Impervious Area Treated
- Less Efficient to treat pervious areas
- Facilities can “focus” recharge ➔ Increases over natural conditions

QUESTIONS ?